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PHYTOPATHOLOGY

VOLUME XI NUMBER 8

AUGUST, 1921

A CONTRIBUTION TO OUR KNOWLEDGE OF SOIL RELATIONSHIPS WITH CITRUS CHLOROSIS

C. B. Lipman

In recent years the subject of chlorosis of plants has received much attention at the hands of investigators. Moreover, such recent investigations have resulted in the discovery of more definite "leads" toward a solution of the problem than any of those carried out prior to eight or ten years ago. We are indebted to Mazé for a clear definition and description of the conditions of chlorosis, to Gile and his associates for some fundamentally important data relative to the possible causes of the disease, and their removal, and to M. O. Johnson for a strikingly successful application of the principles set forth by the other investigators to the problem of pineapple chlorosis in the Hawaiian Islands. All of these are too well known to my readers to necessitate detailed discussion here. Despite all this, however, the problem of citrus chlorosis has seemed to remain proof against all attempts to discover an unequivocal answer for a cause and a cure therefor. While a lack of usable iron for the normal functioning of the chlorophyll in citrus leaves has seemed and still seems the best explanation for the cause of citrus chlorosis, many puzzling features surround the disease which inhibit our taking a definite stand with respect to the matter. It will be profitable for us, therefore, to advert to the conditions which the writer in common with W. P. Kelley and perhaps others, has found to obtain in chlorotic citrus orchards of California.

In my experience, the marked yellowing or even blanching of the entire leaf of the citrus tree always occurs on soils which have either a large excess of calcium and magnesium carbonates (calcareous subsoils) or a large excess of sodium and potassium carbonates. In both cases, the reaction of soil and soil solution is markedly alkaline. Usually the corral soils give marked effervescence when treated with acid. The soil of the corral is very soft and ashy in consistency. It is so markedly different in this respect from the normal soil which surrounds it that the

difference in resistance to the pressure of the feet when one steps from the corral to the normal soil is at once noticed. As would be expected from the foregoing, the corral area is very sharply delimited from the normal soil around it. This delimitation is just as marked in the appearances of citrus trees in an orchard which includes both corral and normal soils.

Whether or not the chlorosis on the two types of abnormal soils mentioned above is identical in nature, it is difficult to say with finality. There are certain differences in the appearance of trees and foliage between the two cases which counsel caution in rendering a decision on the point in question, and yet, in general, the disease seems to be the same. The two abnormal soil conditions are, however, quite distinct from each other. The highly calcareous subsoils are most frequently found underlying heavy, black adobe or "dry bog" soils at a depth of from 12 to 24 inches. The highly basic soils, rich in alkali carbonates, of the second type of chlorotic citrus trees usually occur in narrowly delimited areas known to farmers as old sheep corrals or old campfire circles, usually the former. The burden of this paper concerns itself with a comparative study of the water soluble matter in the soil of an old corral and that adjacent to it just outside the limits of the corral. The trees on the corral soil were found to be badly chlorotic. Those on the adjacent soil were in practically all respects normal or, at any rate, free from chlorosis.

Samples of soil were taken from the affected and the normal areas in such a manner that successive, eight-inch depths down to a total of twenty-four inches were represented. In other words, three layers of the soil were each represented by a composite sample from each area. These soil samples were sent to the laboratory and were extracted with water, one part of soil and two parts of distilled water being used for preparing the extracts. The latter were filtered after several hours of contact between soil and water had been allowed. In addition to this procedure, another was followed, namely the mixing of the samples from the three different depths, thus giving one composite sample for the twenty-four inch column. The composite sample of the whole column was extracted similarly to the others. This experiment was carried out prior to our investigations on soil variability and was, therefore, not as well controlled in that respect as it should have been. The difference between the normal and abnormal soils are so great, however, and especially as regards certain important constituents, as to preclude the factor of variability from affecting the results and conclusions in any significant way.

The soil extracts described were analyzed by the carefully devised methods for the analysis of water extracts in vogue in this laboratory, and largely perfected in the laboratory of Agricultural Chemistry at this university. The results of the analyses are given in table 1. The soil from the corral is designated "corral" in the table. The soil from among the unaffected trees is marked "normal."

TABLE 1

Analyses of soil extracts of corral and normal soils

	8 IN. DEPTH		16 IN. DEPTH		24 IN. DEPTH		COMPOSITE OF 24 IN. COLUMN	
	CORRAL P. P.M.	NORMAL P. P.M.	CORRAL P. P.M.	NORMAL P. P.M.	CORRAL P. P.M.	NORMAL P. P.M.	CORRAL P. P.M.	NORMAL P. P.M.
Total solids....	576.	728	336	412	432	468	1344	1608
Non-volatile solids.....	404	452	104	224	280	208	788	884
Volatile solids..	172	276	152	188	152	260	476	724
NO_3	96	376	56	128	48	320	200	824
Fe.....	9	8	..	..	..	..	9	8
Ca.....	16.0	67.8	14.2	48.8	11.8	63.8	42	180.4
Mg.....	9.3	15.4	6.3	11.7	5.6	18.9	21.2	46.0
P.....	16.0	7.2	12.7	1.6	18.6	3.6	47.3	13.4
K.....	28.6	26.8	37.8	16.3	28.6	10.8	95.0	53.9
Na.....	81.0	45.6	21.8	27.6	48.7	19.1	151.5	92.3

It can be seen even from a cursory examination of the data that the comparison of the extracts from the corral and the normal soils is very striking. To do proper justice to the evidence, it is, perhaps, best to consider briefly the comparison of each of the constituents determined as between the two extracts. The total, volatile, and non-volatile solids may perhaps be considered together. In all cases, but one, the normal soil contains more of each of these constituents than the corral soil, and this is particularly marked in the composite sample for the twenty-four inch column of soil. On á priori grounds, one would expect the volatile solids to be higher in the sheep corral soil than in the normal soil, but that is evidently not the case. Whether the difference is due entirely to the difference in nitrate content between the two soils, is not clear from the data, though it is probable that that is not so.

The nitrate content of the normal soil is enormously greater than that of the corral soil. This, again, is a condition which one would not expect both from a consideration of the corral soil and from that of the greater assimilation of nitrates by the trees on the normal soil.

The situation with regard to the iron content of the two soil extracts is one which has contributed to the statement made above relative to the

need for caution in arriving at conclusions relative to the cause of citrus chlorosis. While there is much indirect and perhaps some direct evidence that a deficiency of iron exists in the chlorotic trees or soils on which they are grown, the data in table 1 give no support for such a conclusion. While there seems to be practically no iron in solution in the subsoils of both corral and normal soils, the surface layers of the two soils seem to contain approximately the same amounts of that constituent. It appears clear that a lack of soluble iron per se in the soil cannot be accountable for the chlorotic condition of the trees in question, otherwise the trees on the normal soil also should be chlorotic.

The calcium and magnesium contents are throughout markedly higher in extracts of the normal than in those of the corral soils. This is particularly true of the calcium content which is from over three to over five times as high in the normal soil extract as in that of the corral soil. This is consonant with the general idea expressed by Kelley and Cummins[1] relative to the calcium contents and perhaps calcium needs of citrus trees with particular reference to its bearing on that other still mysterious citrus disease "mottle-leaf." In general, it would seem that the water soluble supply of calcium and magnesium is insufficient in the corral soil, particularly when the important concept is appreciated that solubility does not necessarily connote or imply availability.

When we come to a consideration of the phosphorous content of the two soil extracts, we find for the first time in our study, that the corral soil is richer than the normal soil. It is not only richer but is markedly so. Indeed, the figures for the phosphorous content of the corral soil extract are decidedly abnormally high, even if both extracts show a high phosphorous content. This is particularly apparent in the extract from the composite twenty-four inch columns. This reversal in characteristic between the two soil extracts as between the constituents above discussed and phosphorous, can hardly be without significance. Without further data and further study, however, I am not prepared to hazard a hypothesis on the nature of its significance.

The strikingly unusual situation just mentioned with regard to phosphorous is further emphasized in regard to the potassium and sodium contents of the two soil extracts. Both in the different eight-inch soil extracts and in the composite samples for the twenty-four inch column the potassium and sodium are markedly higher in the corral than in the normal soil extract. Indeed they are plentiful enough in the corral soil extract as shown by the analyses for the composite sample to indicate possible direct injury to the trees from excess of those bases alone.

[1] Kelley, W. P. and A. B. Cummins, Composition of normal and mottled citrus leaves. Jour. Agric. Res., **20**: 161–191. Nov. 1920.

When the high hydroxyl-ion concentration, and the relatively high content of other anions in the corral are taken into consideration, the case looks even stronger.

That in these two markedly different soils the grouping of the NO_3, Ca and Mg on the one hand and the P, Na and K on the other, should be diametrically opposite, appears to me to be of very profound significance, especially when taken in conjunction with the important findings of Kelley and Cummins regarding the composition of normal and "mottle-leaf" citrus tissue. We may find in these circumstances the key to the solution of one of our most important problems in physiological balances as related to plant growth in a medium like the soil solution. The abnormalities, whatever they may be found later to signify, are apparent at once in the case of the corral soil. It is not often that one encounters such satisfying and striking divergences in comparative studies of soil extracts or soil solutions from soils situated so close to each other. The data are particularly astounding and, to me, very significant as regards the relationships of the Mg and P in the corral and the normal soils.

SUMMARY

In a comparative study of soil extracts from soils which bear respectively normal and chlorotic citrus trees, the following interesting facts were adduced. The chlorotic trees grow in a sharply delimited area in the orchard studied and seem to be confined to areas known as sheep corrals. The latter may represent soil modified by much organic excreta but may also contain wood ash from camp fires, and ash from burnt brush or prunings.

1. In the soil extracts, the total solids, nonvolatile solids, volatile solids, nitrates, calcium, and magnesium are very much greater in extent in the normal than in the corral soil. Not only are the relative values markedly different in the two cases, but the absolute figures are very high for the constituents named in the normal soil and not so for the corral soil.

2. Just the reverse is true as between the two soil extracts for the following constituents: phosphorous, potassium, sodium.

3. There is no clue to an explanation of the chlorosis in the data for the iron content of the two soil extracts.

4. A hint of the possible correlation between the composition of the soil extracts and the discovery of the cause of the disease in this case is given.

THE REACTION OF FIRST GENERATION HYBRID POTATOES TO THE WART DISEASE

C. R. Orton and Freeman Weiss[1]

The striking differences in the reaction of different potato varieties to the presence of the potato wart organism, exhibited in a range comprising all degrees of susceptibility up to complete and apparently permanent immunity is the most noteworthy feature of this disease from both the scientific and practical standpoints. Varietal tests have been carried on in England and in Germany which have set at rest all doubt that immunity to the wart disease is an inherent varietal character quite as specific and consistent as those upon which horticultural classification is based. Similar tests conducted in America, while less extensive as regards number and duration, point no less certainly to this same conclusion. The genetic behavior of this character has therefore been the subject of much interest since the discovery of immune varieties. Appel[2] has discussed the heritability of the immune character as brought out by results obtained in Germany from tests which included both the parents and the progeny of a number of standard varieties. At that time, the information available as to the parentage of many varieties, and the reaction of the parents to the wart disease was too meager to indicate more than that a variety might transmit its immunity or susceptibility to its progeny. In England the varietal tests have included both a large number of named varieties and also a very large number of seedlings (839 in 1919) which had been sent in for trial by seedsmen and gardeners.[3] Seedlings received in this way are not likely to be accompanied by authentic records of the parentage, and the present writers are not aware of any report in which the behavior of these seedlings with respect to the wart disease has been discussed in relation to that shown by the parents.

[1] Joint contribution from the Federal Horticultural Board, and from the Department of Botany of the Pennsylvania State College, No. 34.

[2] Appel, Otto. Über die Anfälligkeit und Widerstandsfähigkeit verschiedener Kartoffelsorten gegen Krebs. Arb. Ges. Förderung Bau. Wirtsch. Zweckm. Verwendung Kartoffeln. Heft **15**. *19 p., fold. tab.* 1918.

[3] Taylor, H. V. The distribution of wart disease. Jour. Min. Agric. London **27**: 733–738, 1920; 946–953, 1921.

In the varietal tests conducted at Freeland, Pennsylvania, and at Thomas, West Virginia, by the United States Department of Agriculture in cooperation with the agricultural experiment stations of these states, exceptionally favorable material for a study of the genetics of immunity to the wart disease has been available in a large collection of seedlings furnished by the Office of Horticultural and Pomological Investigations of the Federal Department of Agriculture. It has not yet been possible to test the parents of all these varieties, yet the reaction of a sufficient number of them has been determined to indicate clearly the heritability of the immune character, and its behavior in the first hybrid generation. An extensive F_1 generation of a number of these hybrids, derived, however, from seed balls formed from open pollination, is now being grown and will be tested in 1921. Further crosses will be made and an F_2 generation from controlled pollination will be grown this year also.

The subjoined tables show the numbers and the reaction of all seedlings which have been tested, together with their parentage and the reaction of the parents, in most cases as determined by our own tests, but in a few instances as taken from published reports of European trials.

It is obvious that these data are inadequate for a clear definition of the genetic character of immunity, yet it may not be unprofitable to discuss them with regard to certain probabilities which may be inferred. Ten hybrids have been tested which have resulted from the cross, immune $\times$ susceptible, or its reciprocal; of these, six are classed as immune and four as susceptible. This approximation to a 1:1 ration is in accordance with expectations if one of the parents, heterozygous for the dominant character, were back-crossed with a pure recessive. No clue is here given as to which character is dominant. Twelve hybrids have been derived from crosses between two susceptible parents and all are themselves susceptible. In connection with the hypothesis advanced above this would indicate that susceptibility is recessive. By this same hypothesis one would expect families derived from immune parents in general to include twenty-five per cent of susceptible forms. Some families should, however, be composed of all immunes. Unfortunately no data are as yet available regarding the behavior of hybrids derived from the cross immune $\times$ immune.

On the other hand, field observations show that some of the hybrids, as is also the case with some named varieties, exhibit various degrees of resistance, falling short, however, of immunity. The tendency toward resistance is shown both in the relatively low number of infected tubers (in some cases not more than one per cent), and in the slight

TABLE 1

*Reaction to wart disease of the parental and F_1 generation of potato seedlings bred by the U. S. Department of Agriculture**

SEEDLING NO.	PARENTAGE PISTILLATE PARENT GIVEN FIRST	PISTILLATE PARENT REACTION	STAMINATE PARENT REACTION	HYBRID
37662	Early Vicktor × Projata	—	±[4]	0
3165	Sophie × Irish Seedling	++[5]	—	0
38899	Prosperity × Farys	—	—	0
39304	Dibble's Russet × McCormick	++	0	0
39168	Green Mountain × Busola	0	++	0
38742	Late Blightless × Busola	—	++	0
1638	Sophie × Keeper	++	0	0
39305	Dibble's Russet × McCormick	++	0	0
39536	Irish Cobbler × Busola	0	++	0
39156	Green Mountain × Petronius	0	+	0
39419	Green Mountain × S. 2321	0	—	0
20026 (No. 19)	? ?	—	—	0
38814	Non-Blight × Busola	++	++	+
38678	Non-Blight × Zbyszek	++	++	++
39215	President Roosevelt × Busola	—	++	++
39366	Manila × Petronius	—	+	++
38859	Non-Blight × Petronius	++	+	+
39324	Manila × Busola	—	++	±
4240	Professor Maercker × Silver Skin	±[4]	—	++
17042	Early Excelsior × Apollo	—	—	++
38748	Rust Proof × Busola	—	++	++
38967	Rural New Yorker × Busola	++	++	±
39500	Irish Cobbler × Busola	0	++	+
39340	Manila × Busola	—	++	+
38759	Carman No. 3 × Busola	++	++	±
39379	Manila × Petronius	—	+	±
39247	Early Rockford × Petronius	—	+	++
38461	Vigorosa × Busola	—	++	+
39622	Irish Cobbler × Petronius	0	+	++
39266	Non-Blight × Busola	++	++	++
39315	Dibble's Russet × Cacha Negra	++	—	++
24642	Aroostook Wonder × Sutton's Flourball	—	0	++
17365	Empire State × Keeper	—	0	+
37803	Irish Cobbler × Busola	0	++	++
38769	Carman No. 3 × Busola	++	++	++
38774	Carman No. 3 × Busola	++	++	+
38816	Non-Blight × Busola	++	++	++

TABLE 1 (Continued)

SEEDLING NO.	PARENTAGE PISTILLATE PARENT GIVEN FIRST	PISTILLATE PARENT REACTION	STAMINATE PARENT REACTION	HYBRID
38880	Non-Blight × Petronius	++	+	±
38946	Prosperity × Busola	—	++	±
38988	Sir Walter Raleigh × Busola	++	++	++
39118	Rural New Yorker × Petronius	++	+	++
39206	Green Mountain × Busola	0	++	±
39256	Early Rockford × Petronius	—	+	+
39285	Non-Blight × Busola	++	++	++
39327	Manila × Busola	—	++	+
39336	Manila × Busola	—	++	+
39374	Manila × Petronius	—	+	++
20050 (No. 6)	? ?	—	—	+

* ++ indicates very susceptible or over 50 per cent of tuber infection.
+ indicates susceptible, or from 10 to 50 per cent of tuber infection.
± indicates slight susceptibility, or less than 10 per cent of tuber.
0 indicates complete freedom from infection.
A long dash indicates that the reaction of the variety is not known.

development of warty outgrowths from such infections as occur. Repeated tests have yielded concordant results for a given variety both in Europe and in our own work and the possible existence of different strains of the pathogene exhibiting variable virulence is therefore not credited. Instead such differences in the degree of resistance or susceptibility shown are believed to be inherent in the variety itself and this would indicate that the extremes of resistance and susceptibility are dependent for their expression upon more than a single factor difference.

In this connection it is worthy of note that the cross Irish Cobbler × Busola, repeated three times, has yielded one hybrid classed as immune, one as moderately resistant and one as very susceptible. Green Mountain × Busola has given in one instance an immune, and in another a slightly susceptible, progeny. Prosperity × Farys has given similar results. In two instances, one the cross Rural New Yorker × Busola and the other Carman No. 3 × Busola, the combination of two susceptible parents has yielded a hybrid which appears to be highly

[4] Schaffnit, Ernst and G. Voss. Versuche zur Bekämpfung des Kartoffelkrebses im Jahre 1915–1917. Zeitschr. Pflanzenkrankh. **26**: 183–192, 1916; **27**: 339–346, 1917; **28**: 111–114, 1918.

Schaffnit, Ernst. Versuche zur Bekämpfung des Kartoffelkrebses im Jahr. 1918–19. Zeitschr. Pflanzenkrankh. **30**: 59–67, 1920.

[5] Appel, O. Op. cit.

TABLE 2

Summary of reaction of F_1 generation in relation to that of parent generation

PATERNAL GENERATION		NO. OF	F_1 GENERATION	
PISTILLATE PARENT	STAMINATE PARENT	CROSSES	SUSCEPTIBLE	IMMUNE
Immune	Immune	0	—	—
Immune	Susceptible	7	4	3
Immune	Unknown	1	..	1
Susceptible	Immune	3	..	3
Unknown	Immune	2	2	..
Susceptible	Susceptible	13	13	..
Susceptible	Unknown	3	2	1
Unknown	Susceptible	15	13	2
Unknown	Unknown	4	2	2

resistant. Such apparent discrepancies are not unexpected when so small a number of plants and so few tests are considered. The effect of ecologic factors upon the development of the disease is also of great importance. Only much more extensive data will make a complete analysis possible.

The prediction seems warranted, however, that the aim of obtaining by hybridization an immune potato conforming otherwise to the type of the Rural New Yorker will be attained only by resorting to pollen parents from a different group as all the varieties of the Rural group seem to be highly susceptible.

DEPARTMENT OF BOTANY
THE PENNSYLVANIA STATE COLLEGE,
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STUDIES ON THE CERCOSPORA LEAF SPOT OF BUR CLOVER

E. F. Hopkins[1]

With Plate XIII and XIV and Three Figures in the Text

The Southern bur clover *Medicago maculata* Willd. one of the most promising leguminous forage crops in the South[2] is severely attacked by *Cercospora medicaginis* E. & E. which causes a characteristic spotting of the leaves. The disease is of wide occurrence and because of its severity is one of the limiting factors in the successful production of this important crop.

SYMPTOMS

Characteristic symptoms of this disease on the leaves are shown in figures 1, 2, and 3. The spots begin as small circular, olivaceous or brown patches dull in lustre with a slightly irregular margin. The color of the spots is apparently due to a superficial growth of mycelium. They may originate either at the margin or towards the center of the leaflet and later enlarge until the whole leaflet or whole leaf is involved. A lesion developing towards the center of a leaflet causes a bleaching of the reddish brown leaf marking of the host. Frequently lesions occur on the leaf petiole in such a manner as to cause the death of the entire leaf.

On the seeds which have been separated from the burs the disease is exhibited by the dark appearance of the seed coats which on closer inspection will be seen to be covered partly or entirely by a network of dark strands. In figures 4, 5, and 6 the contrast between diseased and healthy seeds is brought out.

OVERWINTERING

The symptoms on the seeds have been briefly described by the writer.[3] The dark strands are made up of hyphae of Cercospora (Fig. 7) and constitute apparently the chief method of overwintering rather than by means of viable conidia in the burs as Wolf has suggested.[4] The fact

[1] The following studies were made by the writer while at the Alabama Agricultural Experiment Station, Auburn, Ala.

[2] Cauthen, E. F. Southern bur-clover. Alabama Agric. Exp. Sta. Bull. 165: 165–176. 1912.

[3] Hopkins, E. F. Overwintering and control of bur-clover leaf-spot. Phytopathology **10**: 66. 1920.

[4] Wolf, Frederick A. Dissemination of bur-clover leaf-spot. Phytopathology **6**: 301. 1916.

that the mycelium is on the seeds easily accounts for the observation of Wolf[4] that in the field cotyledons are frequently found to be infected by Cercospora.

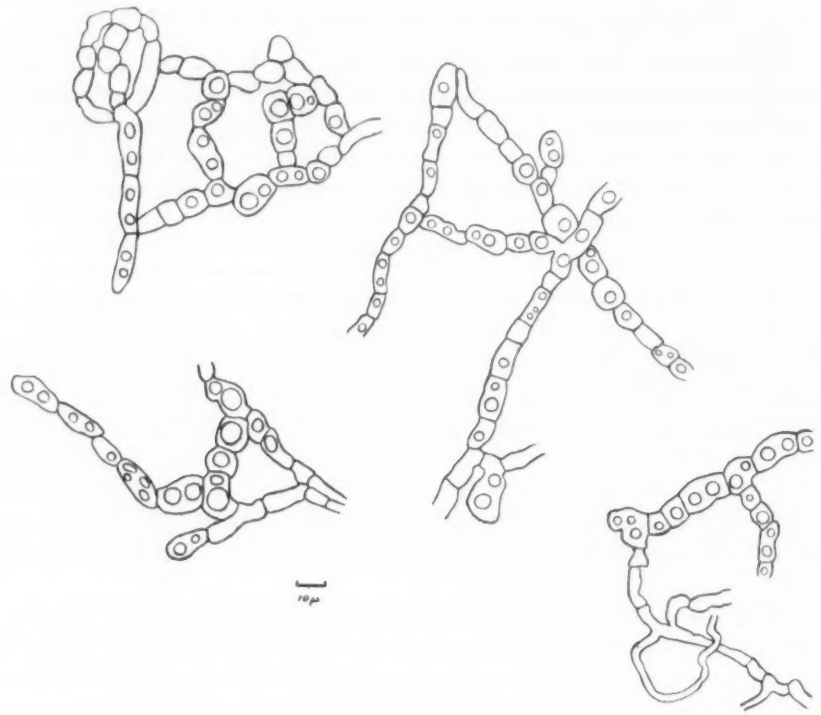


FIG. 7. MYCELIUM OF CERCOSPORA FROM AN INFECTED SEED
Note the pronounced anastomosing of the superficial hypae, the cells of which are dark colored and thick walled. These connect with hypae within the seed coat consisting of more elongated cells, of smaller diameter and hyaline in appearance.

Isolations of the organism were made as follows: the infected seeds were immersed in 95 per cent alcohol for a few seconds, in order to "wet" the surface and then transferred to a 1:1000 mercuric chloride solution for 30 seconds. This was followed by rinsing in sterile water and finally the seeds were planted on poured plates of potato dextrose agar. Almost invariably pure cultures of the fungus were obtained.

By partial drying of plate cultures of this organism abundant conidia of *Cercospora medicaginis* were obtained. This shows beyond doubt that mycelium of this fungus is borne on the seeds. The pathogenicity of the organism thus obtained was demonstrated by inoculation of healthy bur clover plants. Infection was obtained both with and without wounding of the leaves previous to inoculation.

EXTENT OF SEED INFECTION

Two samples of seeds gathered in 1919 from the Alabama experiment station plots were examined in order to determine the percentage of seeds infected with *Cercospora medicaginis*. They were removed from the burs and sorted into three classes: (1) those badly infected, (2) those showing evidence of infection under the low power of the microscope, and (3) those apparently healthy.

TABLE 1

Extent of seed infection

CLASS	LOT 1		LOT 2	
	NO. SEEDS	PER CENT	NO. SEEDS	PER CENT
Macroscopic lesions	71	19.88	326	49.02
Microscopic lesions	161	45.09	163	24.51
Apparently healthy	125	35.03	176	26.47
Total	357	100.00	665	100.00

The two samples therefore show a total infection of 65.0 per cent and 73.5 per cent respectively. Such a large percentage of seed infection is the probable explanation of the severity of the disease in the field.

The badly diseased seeds were found to be lighter in weight than the healthy ones. For example 250 badly diseased seeds weigh .5596 grams as compared with .5771 grams the weight of 250 healthy seeds. A difference of .0175 grams in favor of the latter. The difference between diseased and healthy seeds is shown very strikingly in plate XIV, fig. 4.

CONTROL

Clean seeds. Before it was found that the disease was seed borne it seemed that if the burs harbored the fungus it might be controlled by removing the seeds from the burs. A sample of burs was picked free from dirt, sticks, etc., the seeds removed by hand and both the seeds and burs were weighed. It was found that the seeds constituted only 30 per cent by weight.

As purchased on the market bur clover seeds contain a considerable amount of "trash" which further reduces this percentage. It appears that clean seeds would be a matter of practical economy. Since the fungus, however, has been found to hibernate on the seeds clean seeds of themselves will not control the disease. This method must be used in connection with others.

Boiling. It is a general practice to boil bur clover seeds principally to hasten the germination of the seeds which have very hard impervious seed coats. The method as recommended by the Alabama Experiment Station is essentially as follows: The seeds are soaked in cold water,

immersed in boiling water for one minute and then immediately plunged back into the cold water again for the two-fold purpose of rapid cooling and reinoculation with the legume bacteria.[5]

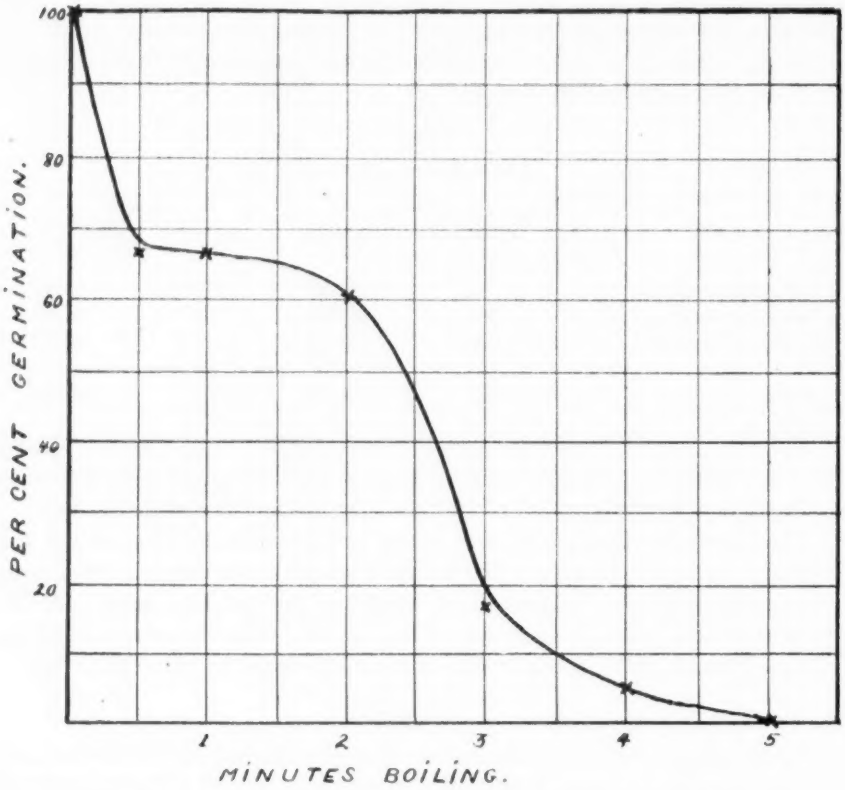


FIG .8. EFFECT OF BOILING ON THE GERMINATION OF SEEDS
Per cent of germination plotted against time in minutes of the boiling period.

A preliminary experiment to test the effect of boiling on the germination of bur clover seeds was made. Ten seeds were used in each test. The length of boiling varied from 1 minute up to 30 minutes. The seeds were placed to germinate in petri dishes on heavy filter paper moistened with tap water.

[5] Duggar, J. F. and Tisdale, H. B. Bur-clover seed: Means of hastening their germination. Alabama Agric. Exp. Sta. Cir. 29: 113–116. 1914.

TABLE 2

Effect of boiling on seed germination

TIME OF BOILING MINUTES	PER CENT OF GERMINATION	
	NOT SOAKED	SOAKED OVER NIGHT
0	0	0
1	50	70
2	40	50
3	60	30
5	20	10
10	0	0
30	0	10

The result for one minute is in fair agreement with those of Duggar and Tisdale (4) who obtained 51 per cent of burs with sprouted seeds without soaking and 76 per cent after soaking four hours.

Similar results were obtained using 100 seeds in each test and planting them in soil in flats.

TABLE 3

Effect of boiling on the germination of seeds in soil

TIME OF BOILING MINUTES	0	1	2	3	4	5
PER CENT OF GERMINATION	10	75	25	20	8	2

The writer wishes to point out an error in this type of experiment viz. the test does not show if one minute of boiling injures the seeds or not. If it is potentially able to germinate 100 per cent under the proper conditions then one minute at the boiling temperature causes considerable injury. That the boiling had made the seed coats permeable is shown by the fact that all the seeds were swollen after the treatment while those ungerminated seeds in the case of no boiling did not swell. Attention was first directed towards this matter by the use of seeds which had been put through a small cotton gin to remove the burs. These showed over 30 per cent germination without boiling. A greater reduction in germination due to boiling was noted and is probably due to the fact that in many instances the seed coats were broken. With this in mind an experiment was performed in which one lot of unboiled seeds was scarified with sandpaper.

It is evident, therefore, that boiling one minute injures the seeds to the extent of about 25 per cent. (See figure 8.) There is also delayed germination. (See figure 9.)

TABLE 4

Germination of boiled seeds compared with scarified seeds

TIME OF BOILING MINUTES	PER CENT. OF GERMINATION		
	TEST 1	TEST 2	TEST 3
0 (not scarified)	2	0	0
0 (scarified)	100	100	100
½ (not scarified)	66	88	90
1 " "	66	84	78
2 " "	60	68	68
3 " "	16	44	48
4 " "	4		
5 " "	0		

The effect of boiling on the fungus. Six badly infected seeds were surface disinfected and then immersed in sterile boiling water for varying periods of time. They were then planted on agar in petri dishes.

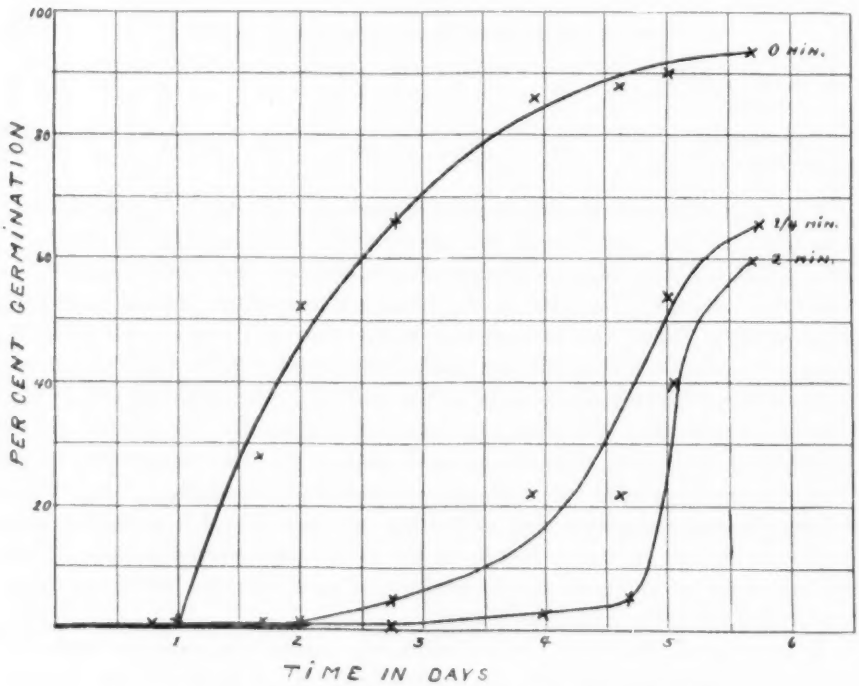
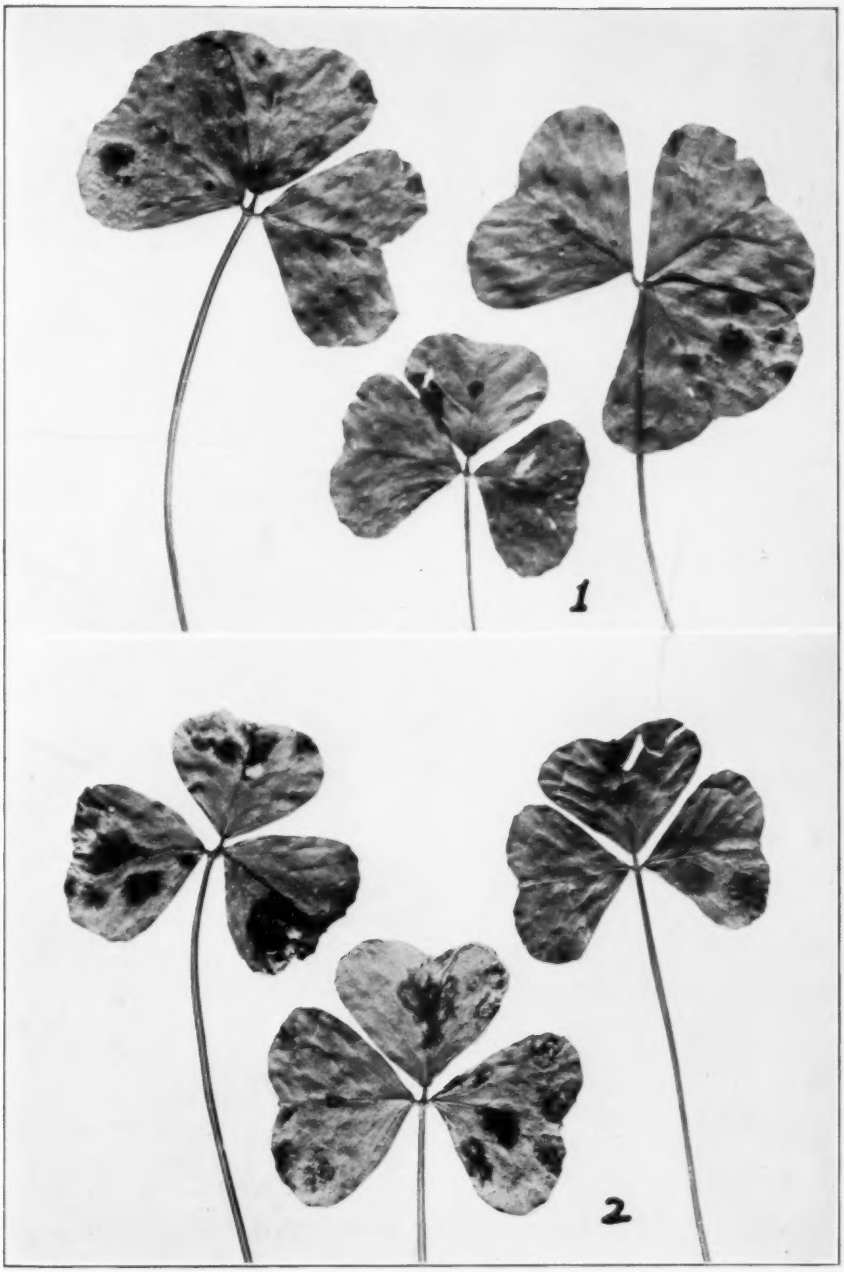


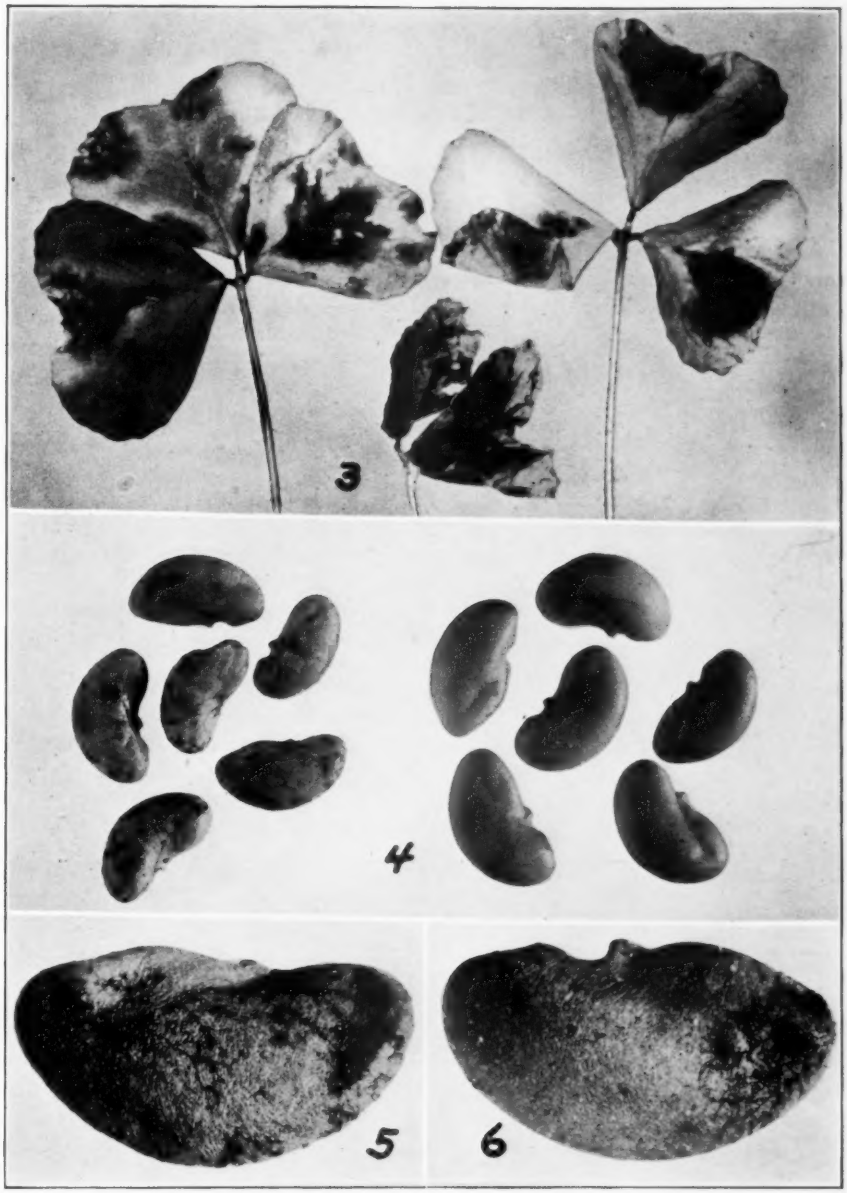
FIG. 9. EFFECT OF BOILING ON THE RATE OF GERMINATION
Per cent of germination plotted against time in days for periods of 0, ½ and two minutes boiling.



SYMPTOMS OF BUR-CLOVER LEAF-SPOT ON THE LEAVES

Fig. 1. An early stage of infection. Note the effect of the infection on the natural leaf marking in the centers of several of the leaflets.

Fig. 2. A more advanced stage of the disease. Several of the leaflets show considerable yellowing.



SYMPTOMS OF THE BUR-CLOVER LEAF-SPOT ON THE LEAVES AND SEEDS

Fig. 3. An advanced stage of infection. Note the lesion on the petiole of one of the leaves.

Fig. 4. Contrast the dark markings on the diseased seed at the left with the appearance of the healthy seed at the right. × about 6.

Fig. 5. An infected seed considerably enlarged which shows a network of mycelial strands over its surface.

Fig. 6. Sometimes the markings are more localized. Note the sclerotia-like structures formed on the mycelium.

With no boiling Cercospora grew out from the seeds while with 1, 2, 3, 4, and 5 minutes boiling no fungus growth appeared. Germination of the seeds was noted in the one minute test. This is an indication that one minute boiling is effective in killing the fungus. This was confirmed in another experiment using 5 seeds in each test. Five colonies of Cercospora were obtained without boiling and none above one-half minute at the boiling temperature.

To test the effect of boiling on the development of the disease, seeds were boiled for varying lengths of time and planted in flats in the greenhouse. One hundred seeds were planted in each flat.

TABLE 5

The effect of boiling on the development of the disease

TIME OF BOILING (MINUTES)	NUMBER OF PLANTS	PER CENT. DISEASED LEAVES
0	9	2.6
1	42	10.0
2	27	5.7
3	9	2.0

This indicates that boiling does not prevent the development of the disease and therefore agrees with the fact that in the field the disease frequently develops on plants from boiled seeds.

Formaldehyde and mercuric chloride. Preliminary experiments with these substances seem to show that they are effective in controlling the disease and that in concentrations one pint to thirty gallons of water and 1:1000 respectively they do not cause decreased germination after 2 hours' treatment.

Recommendations. The Cercospora leaf-spot disease of bur clover is seed borne and therefore in controlling it attention should be directed towards seed treatment. This is particularly important since in some cases over 70 per cent of the seeds are infected with this fungus. Heretofore the practice of boiling the burs one minute has been the only means suggested for the control of this serious disease. This is, however, ineffective under field conditions and indeed causes injury to the seeds, as evidenced by a decrease in the percentage of seeds germinating. Germination is also delayed. There is no doubt that this practice should be discontinued both from the standpoint of cultural practice and of disease control.

The writer would suggest the following procedure: 1. that seeds free of burs be used, 2. that the seeds be treated with formaldehyde solution to kill the fungus mycelium on the seed coats, 3. that the seeds be scarified, and 4. inoculated with legume bacteria.

The first point involves a problem for the agricultural engineer. The burs are very compact and the seed is not easily removed. Some progress has already been made along this line and it seems that the problem will not be difficult to solve. Although experiments are not as yet conclusive formaldehyde solution should control the disease as the mycelium is quite superficial. Thorough scarification following this treatment would then give rapid and complete germination of viable seed. Inoculation is advised, of course, unless inoculated soil is used.

CONCLUSIONS

(1) The Cercospora leaf-spot of Southern bur-clover, caused by the fungus *Cercospora medicaginis* E. & E. which is responsible for considerable damage to this crop is carried over from one season to another by means of mycelium on the seed coats.

(2) The extent of seed infection is shown to be very large.

(3) Boiling bur-clover seed shows considerable injury to the seed as indicated by reduced and slower germination.

(4) In practice boiling the seeds does not prevent the disease.

(5) Experiments thus far indicate that the disease may be controlled by treating the seeds with formaldehyde solution.

(6) It is suggested that hulled seeds treated with formaldehyde scarified and inoculated with the legume organism will give good stands of bur clover free from the Cercospora leaf-spots.

SOME NEW OR LITTLE KNOWN HOSTS FOR WOOD-DESTROYING FUNGI. III

ARTHUR S. RHOADS

In two previous articles (4, 5) the writer has emphasized the desirability of studying the wood-rotting fungi from the broader concepts of their host and ecological relationships, inasmuch as a knowledge of the host is often a valuable aid in the determination of even the wood-rotting fungi. Aside from a few species, such as *Fomes pinicola*, *Polyporus sulphureus*, and *Armillaria mellea*, which grow on coniferous or dicotyledonous wood with equal facility, the wood-rotting fungi may, from an ecological standpoint, be roughly divided into a coniferous wood association and a dicotyledonous wood association, in accordance as they grow on either one class of wood or the other with more or less regularity. Many species are so nearly constant in their habit of growth on either one or the other of these classes of wood, or even on genera of wood, that mycological workers in the past have attached great significance to this point, in fact too much. Even the wood-rotting fungi thought to be confined to a certain class, or even genus of wood have their exceptions, as critical studies of the fungi under field condition are constantly showing.

In view of our gradually increasing knowledge of the host relationships of the wood-rotting fungi the writer believes that in taxonomic work more attention should be paid to the study of the morphology of the wood-rotting fungi than to their host limitations, at least as embodied in such narrowly limited captions as are often employed as diagnostic features in keys. Not infrequently mycologists have been influenced by host relationship or geographic distribution in describing specimens of fungi as new species, when a critical study of the morphology would have assured them that the specimen in question was merely a well-known species occurring on a new host or from a quite different locality than hitherto known. Intensive field studies along these lines should imbue the taxonomic worker with a greater regard for latitude in his concept of our species, which, in the wood-destroying fungi at least, are at best but arbitrarily defined.

Inasmuch as there is more or less of a definite association of wood-rotting fungi on conifers and on hardwoods it is of interest to note the occasional departure of the fungi from their accustomed hosts. In continuance of the observations recorded in two previous papers on new

or little known hosts for wood-destroying fungi, the writer wishes to cite the following cases that have come to his attention recently. All collections cited were made personally unless otherwise noted, and are given either because of the marked departure of the fungi from their usual coniferous or dicotyledonous hosts, or of the ability of fungi ordinarily growing saprophytically, to attack the wood of living trees.

OCCURRENCE OF WOOD-DESTROYING FUNGI ON UNUSUAL HOSTS

Schizophyllum commune Fries

On a windthrown trunk of *Picea rubens*, Tuckerman Ravine Trail, Mt. Washington, New Hampshire.

On a chute pole of *Abies concolor*, in abandoned log chute, Plumas National Forest, near Massack, California.

On *Sequoia sempervirens*, growing on sapwood of slab left after tie manufacture, Lagunitas, California.

Hymenochaete tabacina (Sow.) Lev.

On a fallen sapling of *Tsuga canadensis*. Specimens collected by Dr. L. O. Overholts and the writer at North Conway, New Hampshire.

On *Sequoia sempervirens*, growing on trunk and branches of fallen sapling, Canyon, Contra Costa Co., California.

Stereum hirsutum (Willd.) Fr.

On fallen branches of *Pinus radiata*, San Francisco, California.

On end of cull logs of *Libocedrus decurrens*, growing on sapwood only. Plumus National Forest, near Massack, California.

On end of cull logs of *Abies concolor*, growing on sapwood. Plumus National Forest, Massack, California.

On *Sequoia sempervirens*, growing at base of dead portion of branch of recently felled tree, Lagunitas, California.

Hydnum ochraceum Pers.

On *Cupressus macrocarpa*, growing on bark of fire-killed trunk in a sand-dune plantation, San Francisco, California.

Polystictus versicolor (L.) Fries

On *Pinus radiata*, San Francisco, California. A fine collection of large sporophores was made from the base of a fire-killed tree in a sand-dune plantation. *Polystictus abietinus* (Dicks.) Quel. was fruiting exceptionally abundantly on a large percentage of the dead Monterey pines on this and other adjacent burns.

On end of log of *Picea sitchensis*, Requa, California.

On charred stump of *Pseudotsuga taxifolia*, Plumas National Forest, near Massack, California.

On cull logs and stumps of *Abies concolor*, Plumas National Forest, near Massack, California.

On *Sequoia sempervirens*, occurring on slash left after logging, Requa, California. Also on sapling of the same species used as rail in rustic fence, Lagunitas, California.

On stumps of *Tsuga heterophylla*, Coeur d'Alene, Idaho.

Abundant on cull logs and fallen trunks of *Libocedrus decurrens*, Plumas National Forest, near Massack, California. The sporophores frequently persist beyond the first season and develop a second layer of tubes with a distinct stratified appearance. The stratification of the tubes of this species appears to be of more or less frequent occurrence.

Polystictus hirsutus (Wulf.) Fries

On stump of *Pseudotsuga taxifolia*. Specimen collected by Dr. J. S. Boyce at Willow Creek, Humboldt Co., California.

On dead tree of *Pinus sabiniana*. Specimens collected by Mr. C. R. Stillinger at Auburn, California. The sporophores had continued growth during the second season and were unusually thick, although the tubes were not distinctly stratified as were specimens collected on *Aesculus californica* by the writer in Marin Co., California. Sporophores of this fungus quite frequently persist for two and sometimes three seasons.

Polystictus abietinus (Dicks.) Quel.

On fallen trunk of *Quercus* sp. Specimen collected in Lagunitas Canyon, Marin Co., California, by Mr. Lewis S. Rose and communicated by Dr. W. A. Setchell of the University of California.

Polyporus caesius (Schrad.) Fries

On fallen branch of *Picea sitchensis*, Requa, California. Although of rare occurrence on coniferous wood in the Eastern United States, *Polyporus caesius* occurs quite often on coniferous wood in the humid forests of the Pacific Coast and Pacific Northwest.

Polyporus cutifractus Murrill

In his description of this recently published species, Murrill (2, p. 8) states that it has been collected on a much decayed fir log in a virgin forest at Newport, Oregon, and also on a maple log and trunks of *Thuya* and *Pseudotsuga* in Washington.

A fine imbricate specimen of what was determined by Dr. W. A. Murrill as this species was collected by the writer on a living and apparently uninjured tree of *Cupressus macrocarpa* on the campus of Leland Stanford University, California. The specimen occurred about two feet above the base in a depression between two fluted portions. Additional specimens of this fungus have been observed growing in a similar manner on living *Cupressus macrocarpa* trees on the campus of the University of California. It also occurs here on felled trunks of the same species.

The above collections will extend the range of this little known species, and add to its hitherto known hosts and habit of growth.

Polyporus carbonarius Murrill

Specimens collected by the writer at San Francisco, California, on *Cupressus macrocarpa* logs used to retain an earth fill, were determined by Dr. W. A. Murrill as representing the normal form of his recently published species, *Tyromyces carbonarius*, which he states was described from specimens that were sodden and quite abnormal on the upper surface. In his description, Murrill (2, p. 8) states that the specimens were collected on a burned red fir log at Seattle, Washington. The writer has made a second collection of the same plant on a *Cupressus macrocarpa* stump, and two others on *Pinus radiata*, one being on a stump and the other on a fallen trunk. All three collections were made in forest plantations in San Francisco, California. These collections extend the hitherto known range and hosts for this species, which also is little known. None of these four specimens, which were collected in an actively growing state, showed any indication of a faint rosy hue to the hymenium, which Murrill (2, p. 9) mentions as being quite characteristic. Neither did the tubes display any irregularity, with long dissepiments suggesting *Irpiciporus* as Murrill states, in his description (p. 8), may occur at times. The writer's specimens also differ from Murrill's description in that the pore mouths, instead of being "subcircular, 4 to a mm., not glistening," are distinctly angular, and minute, varying from 4–5 to a mm., and with a distinct sheen to the pore mouths in normally developed specimens.

Polyporus leucospongia Cooke & Hark.

On piece of fallen sapling of *Populus tremuloides*, Plumas National Forest, near Massack, California.

Polyporus dichrous Fries

On fallen trunk of *Pinus radiata*, Pebble Beach, Monterey Peninsula, California. Specimen collected by Dr. E. P. Meinecke.

Polyporus picipes Fries

On log of *Abies balsamea*, Willey House, New Hampshire. Specimen collected by Dr. L. O. Overholts and the writer.

Polyporus Berkeleyi Fries

On *Picea sitchensis*, growing on roots of living tree, Requa, California. In the central and eastern United States this fungus is usually found on oaks; along the Pacific Coast and in the northwestern United States it usually grows on conifers.

Polyporus nidulans Fries

On dead tree of *Tsuga canadensis*. Specimen collected at Ormstown, Quebec, Canada, by Prof. R. J. Blair (No. 144) and communicated by Dr. L. O. Overholts (Herb. L. O. Overholts, No. 4084).

Polyporus Schweinitzii Fries

On charred stump of *Eucalyptus globulus* in a pure plantation of that species, San Francisco, California. A single small stipitate specimen was found growing out of the top of a stump about which a fire had been built.

To the best of the writer's knowledge this is the first report in this country of the growth of *Polyporus Schweinitzii* on dicotyledonous wood. This specimen is of unusual interest by reason of its occurrence on wood of an exotic tree. Both the eucalypts and acacias, now so extensively planted in California, are quite susceptible to a number of our common wood-rotting fungi.

Polyporus dryadeus (Pers.) Fries

On *Abies concolor*, Trinity National Forest, California. While working over the collections of forest tree fungi in the San Francisco office of Forest Pathology, the writer found an undetermined collection of this species on *Abies concolor*. Whether the sporophores were growing on a living or dead tree is not known, but the orientation of the sporophore with regard to the attached bark testifies that the tree was erect, and the appearance of the bark, that it probably was living.

On *Abies grandis*, the sporophores occurring from 1½–2 feet above the ground-level on a living tree 48 inches in diameter, and causing a saprot. Specimens collected by Dr. J. S. Boyce at Randle, Lewis Co.,

Washington. Recent reports indicate that this fungus is not so rare on coniferous trees as was formerly supposed.

Long (1, p. 247) mentions three collections of *Polyporus dryadeus* on *Tsuga heterophylla* from widely separated parts of the State of Washington, which were collected by Dr. C. J. Humphrey with the statement that the sporophores were attached to the host at or near the surface of the ground and that the plant is a true parasite and kills the tree as it attacks. Murrill (3, p. 41) refers to the same collections of this fungus on *Tsuga heterophylla* and states that he has it from Oregon on this host and on *Abies grandis*. Recently Weir (6) states that *Polyporus dryadeus* occurs most frequently on *Tsuga heterophylla* and *T. mertensiana* and that it has also been collected on *Abies grandis* and *Picea Engelmanni*. The occurrence of this fungus on coniferous hosts is now known from California, Oregon, Washington, Idaho, and Montana.

Fomes Meliae (Underw.) Murrill

On *Ginkgo biloba*, Washington, District of Columbia. The sporophores collected were growing on the margin of dead wood left after sawing off a large limb, occurring just in advance of the callus formation. This collection was made in the fall of 1918. One year previous to this the writer's attention was directed to sporophores of *Polystictus hirsutus* (Wulf.) Fries growing on the same area of dead wood (5). *Fomes Meliae* rarely departs from the genera, *Fraxinus*, *Gleditsia*, and *Melia*.

Fomes applanatus (Pers.) Wallr.

On stump of *Tsuga heterophylla*, near Orick, Humboldt Co., California.

On fallen trunk of *Picea sitchensis*, Requa, California.

On fallen trunk of *Pseudotsuga taxifolia*, Requa, California.

On fallen trunks of *Abies concolor*, Plumas National Forest, near Cascade, California. In the central and eastern United States *Fomes applanatus* almost always occurs on dicotyledonous wood; in the West, however, its occurrence on coniferous wood is fairly common in the humid regions.

Lenzites saepiaria (Wulf.) Fries

On *Alnus incana*, growing on a wounded living tree which showed the characteristic rot of this fungus. Specimen collected in Reitz Gap, Center Co., Pennsylvania, and communicated by Dr. L. O. Overholts (Herb. L. O. Overholts, No. 3444).

On piece of *Populus tremuloides* trunk, producing the characteristic decay of this fungus, Plumas National Forest, near Massack, California.

This species and its characteristic rot have also been collected on a fallen sapling of the same host at Spokane, Washington.

The decay caused by this fungus on hardwoods can not be distinguished from that caused by the closely related species, *L. trabea*, which commonly occurs on hardwoods.

UNUSUAL OCCURRENCE OF NORMALLY SAPROPHYTIC WOOD-DESTROYING FUNGI AS WOUND FUNGI ON LIVING TREES

Among the wood-rotting fungi are several that normally occur as saprophytes, but, under certain conditions, sometimes attack the wood of living trees after gaining entrance to them through wounds of various kinds. The following instances, based upon the writer's field collections, are cited as exemplifying the ability of normally saprophytic wood-inhabiting fungi to assume the role of a wound fungus.

Schizophyllum commune Fries frequently attains a luxuriant growth on street, ornamental, and fruit trees, after establishing itself in dead areas induced by wounds in living trees. The occurrence of this fungus as a wound fungus has been noted on *Rhus hirta* in New York, Pennsylvania, Maryland, Virginia, and District of Columbia, on *Rhux vernix* in Massachusetts; on *Acer rubrum* in Pennsylvania; on *Acer saccharum* and *Cedrela sinensis* in New York (the latter collection by Mr. G. F. Gravatt); on *Acer platanoides* in the District of Columbia; on *Ceanothus thrysiflorus*, *Acacia melanoxylon*, and other species of *Acacia* in California.

Polystictus hirsutus (Wulf.) Fries has been observed as a wound parasite on a vigorously growing ornamental cherry (*Prunus* sp.) tree at Spokane, Washington.

Polyporus gilvus (Schw.) Fries likewise occurs on living forest and street trees injured in various ways. Its occurrence in this manner has been noted on *Quercus coccinea* and *Acer saccharinum* in Pennsylvania, on *Platanus occidentalis* in Pennsylvania and the District of Columbia, and was recently reported by the writer (4) as occurring as a wound parasite on *Rhus toxicodendron* in Maryland.

Fomes applanatus (Pers.) Wallr. frequently assumes the role of a facultative parasite, attacking not only older trees in which the vitality has become considerably lowered, but also younger trees making a vigorous growth. White (7), who recently has made a comprehensive study of this species, definitely proves that it may occur as a true wound parasite. He states that it is very destructive in southern Ontario and gives a list of the living species known to be attacked. Its occurrence as a root parasite on aspens has commonly been observed in various sections of this country. In addition the writer has observed its occurrence as a wound parasite in the following instances: on *Quercus*

alba in Pennsylvania; on *Quercus rubra* in New Hampshire; on *Fagus atropunicea* in Maine; on *Eucalyptus globulus*, *Crataegus* sp., *Acacia* sp., *Umbellularia californica*, *Schinus molle*, and *Quercus agrifolia* in California. In the three last named species *Fomes applanatus* causes a very destructive heart rot.

Fomes pinicola (Sw.) Cooke, which is of comparatively rare occurrence on living trees, was noted growing out of an open fire scar on a small suppressed, living sapling of *Abies concolor* on the Plumas National Forest, near Massack, California. A specimen in the San Francisco office collected by Dr. E. P. Meinecke on the Stanislaus National Forest in California, grew out of a fire scar on a good sized living tree of *Pinus lambertiana*, causing an extensive rot of the heartwood. The occurrence of *Fomes pinicola* has also been noted on a living tree of *Pseudotsuga taxifolia* at Spokane, Washington. In this case three sporophores occurred near the ground-level, one on each of three sides of the base, where the bark had been killed by fire.

Fomes roseus (Alb. & Schw.) Cke. has been observed in Humboldt Co., California, causing a destructive heartrot in living trees of *Pseudotsuga taxifolia*.

Trametes suaveolens (L.) Fries and *Daedalea unicolor* (Bull.) Fries have been observed attacking living trunks of *Salix* sp. in Maine.

The writer takes this occasion to correct an error in the identity of a fungus in the first paper of this series (4). The specimen of *Coriolellus sepium* (=*Trametes sepium*) cited on a stump of *Tsuga canadensis* (p. 47) proves to be the extremely variable *Trametes heteromorpha* Fries, a species then but poorly understood in this country.

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EUGENE WASHBURN ROARK

L. R. Jones and G. W. Keitt

Eugene Washburn Roark was born at Lexington, Ky., Sept. 5, 1894, and died at Minneapolis, Minn., Oct. 14, 1918. He spent his early youth at Lexington, where his father occupied the chair of education in the University of Kentucky. He received his early education in the schools of Lexington and Richmond, from which he went to Clark College, where he was granted the degree of Bachelor of Arts in 1914. Throughout his undergraduate training he continued to develop the naturalistic bent of his earlier youth and turned to the biological courses in anticipation of later specializing in plant pathology. In 1914 he entered the University of Wisconsin as a graduate student in plant pathology. His first research work comprised a very creditable study of certain aspects of the relations of *Phytophthora infestans* to the potato and the tomato. The results of these studies were presented as a thesis for the degree of Master of Science in 1915. From 1915 to 1917 he served as assistant in the Department of Plant Pathology and in 1918 he was awarded a fellowship in this department. Throughout this period, he rendered faithful services of the highest quality, particularly in relation to the fruit disease courses and investigations of the department. At the same time, he prosecuted his own studies and research work with vigor and success.

The entrance of the United States into the war brought responsibilities which Roark met unflinchingly, and in the fulfillment of which he later gave his life. While awaiting his call to the colors, he carried the entire burden of the fruit disease work of the department, in the absence of the other members of that section of the staff, and at the same time completed the work for his doctorate, which was conferred in June, 1918. His doctor's thesis was a highly creditable dissertation on "The Septoria Leaf Spot of Rubus." On Sept. 3, before he had been able to finish preparing his thesis for publication, he responded to his call to the colors and entered the Naval Aviation Service at Minneapolis. After a brief period of training, he contracted influenza which rapidly developed into pneumonia, to which he succumbed on Oct. 14, 1918.

Dr. Roark combined in a rare way the characteristics of the sincere friend, the courteous gentleman and the scholarly scientist. The keen sense of personal loss on the part of his university associates is tempered only by the realization that he entered his country's service with deliberation and devotion, ready to give without stint of his splendid young manhood, and it remains their privilege thus to continue to share in some small degree in his supreme sacrifice.

THE SEPTORIA LEAF SPOT OF RUBUS

E. W. Roark[1]

The fungus formerly known as *Septoria rubi* Westendorp causes leaf spots on many species of Rubus (blackberries and raspberries) and attacks the stems of some of these species. The disease occurs throughout Europe and North America. In the United States it has been reported from all but seven states, and is present in all sections where the hosts are grown to any considerable extent.

Wherever found, it is usually quite common but rarely serious. It cannot be considered a major disease of bramble fruits. The chief damage done is brought about by early defoliation, which inhibits normal bud development and predisposes the canes to winter injury.

The leaf spots vary in appearance on different hosts but at maturity usually show light colored centers with brownish or reddish borders. The pathogene also causes inconspicuous lesions on the petioles and canes of some hosts.

The leaf spot fungus was named *Septoria rubi* by Westendorp about 1850. This name was antedated by the possible synonyms, *Ascochyta rubi* Laschin 1832 and *Ascochyta ruborum* Libert in 1834, but as the identity of the forms thus named has not been definitely proved, it seems advisable, for the present, to retain Westendorp as authority for the species name.

The ascigerous stage, first found in 1917 in Wisconsin, is a species of Mycosphaerella which in its morphology does not agree with any published descriptions of fungi occurring on Rubus. It seems necessary, therefore, to describe it as a new species.

Proof of the relation between the imperfect and the perfect form is based on: 1. constant association of the two in the locality where peri-

[1] When Dr. Roark responded to his call to military service, he had completed the preliminary draft of his doctor's dissertation and had prepared an abstract which was filed with the university authorities for publication in the event of his being unable to complete the preparation of his paper. The fuller paper was so nearly ready for release and was so meritorious that publication of this abstract has been postponed in the hope that the original paper might yet be edited and published. This has not been feasible, due to the fact that the plates and certain other important sections of the paper have not been found since Dr. Roark's death. It is supposed that, working under extreme pressure, he took some of his material with him for the final touches when he went into the service, and that due to his sudden and untimely death, he was unable to leave the necessary directions for its disposition. Under these circumstances, his abstract is being published, and the available parts of the original paper are being placed on file in the university library.—G. W. Keitt.

thecia have been found, 2. cellular connection of perithecia and pycnidia on the same dead leaf; 3. similar behavior of ascospores and pycnospores in germination, and similarity of the two in pure culture; 4. positive results from inoculations with spores from the ascigerous stage.

Pycnidia formed in spots on green leaves vary from typically well formed pycnidia to thin walled, imperfectly formed fruiting bodies which approach the acervulus in structure. Pycnidia formed on dead leaves are thick walled, closely grouped, and arise from heavy stromateoid masses of mycelium. It has seemed best in the discussion of these pycnidial forms to designate them, respectively, as summer pycnidia and winter pycnidia.

After a study of perithecia from the different hosts the perfect stage is described as follows:

Mycosphaerella rubi n. sp. Perithecia mainly hypophyllous, sometimes amphigenous, usually gregarious, erumpent, globose, 60–80μ in transverse diameter with a short papilliform ostiole, black, walls pseudoparenchymatous, two or three cell layers thick, aparaphysate; asci subclavate to cylindrical, eight-spored, very short pedicellate, 42–45 by 8–10μ in water; ascospores hyaline, slenderly fusiform, of two equal cells, straight or slightly curved, very slightly constricted at septum, 20–25 by 3.50–4.25μ, extreme limits in length 17–28μ, sometimes tending to occur in fours in the ascus, usually irregularly biseriate. Conidial stage: *Septoria rubi* Westendorp. Hab. on fallen leaves of *Rubus strigosus*, *R. parviflorus*, *R. allegheniensis* and *R. hispidus* in Door County, Wisconsin.

In studies of the germination of pycnospores and ascospores it was found that they readily germinate in water and nutrient solutions and that pycnospores reflect strain differences in their variable behavior in germination. Some pycnospores and ascospores have shown a definite reaction to strong, diffused sunlight, the developing germ tubes exhibiting negative heliotropism.

The minimal temperature for germination in water or in a favorable nutritive medium is slightly below 2° C.; the optimal, between 18° and 26°, about 23°; and the maximal, about 32° or slightly above.

About fifty strains of the fungus have been carried in pure culture, isolations having been made at different times of the year from the leaves and canes of various host species. Strains from the same or different hosts varied considerably in regard to type and amount of spore production, and in stromatic development, some readily forming pycnidia, while others formed only masses of needle-shaped secondary conidia. When grown on about thirty media, the fungus showed only minor variations, except that Lima bean agar was found to favor the production of secondary conidia even in case the fungus was usually stromatic.

The minimal temperature for growth on a nutrient substratum, potato agar, is less than 2°C., the optimal, between 20° and 23°; and the maximal, about 32°.

It is believed that the production of secondary conidia is primarily a strain characteristic varying greatly with different strains, but that within a given strain it can be encouraged to a certain extent by crowding of spores at the time of germination, frequent transferring, use of special media, and optimal temperature for growth.

The stromateoid type of pure-culture growth will live for several months at room temperature (about 22° to 25°C.); but, at the same temperature, cultures consisting of masses of secondary conidia lose their viability within about two weeks.

The results of many inoculations with spores derived from both pycnidia and perithecia may be briefly stated as follows: 1. spores from the ascigerous stage were found to produce leaf infection, resulting in lesions which sometimes contained typical pycnidia but usually imperfectly formed fruiting bodies; 2. the stem form of the fungus was proved to be identical with the leaf form; 3. blackberry strains would not cross to raspberries, nor would the raspberry strains infect blackberries. Conclusions were drawn from no inoculations except those which were adequately controlled by uninoculated plants and from which successful reisolations were made.

The fungus commonly overwinters as mycelium and immature pycnidia in dead leaves and, in the case of red raspberries, in the bark on canes. Perithecia are a factor in the overwintering, but are restricted in occurrence.

In Wisconsin, leaf spots usually begin to appear two or three weeks after the leaves are well opened and continue to increase in number until frost, the amount of infection depending primarily upon weather conditions.

Primary infection is brought about mainly by newly formed pycnospores from overwintering pycnidia on dead leaves or bark, though ascospores may also function in this way. Secondary infection throughout the season is caused by pycnospores from the current-season lesions.

Mature ascospores can be found late in May, and continue to develop well into July—occurring most abundantly during June. Pycnidia are formed in practically all lesions, their frequency depending somewhat upon the host variety. Viable pycnospores can be found throughout the year but are more abundant at certain times. This is due to the fact that there are usually so-called waves of infection which are correated with periods of rainfall.

The period of incubation for the fungus in leaves was found to vary from 8 to 11 days in most inoculation experiments, although wider variations sometimes occurred. From observations it would seem that in nature the incubation period may show even greater variations.

Field infection is favored by moderately cool weather and frequent periods of rainfall.

As a result of observations and experiments, it is believed that the disease is spread into cultivated plantations primarily by diseased nursery stock, the fungus being carried in the bark or persistent leaves. The principal agents of spore dissemination are wind in case of the ascospores, which are forcibly discharged into the air, and splashing or wind-borne rain in case of pycnospores, which exude in masses and can be scattered only after being separated in water.

Among the host species and varieties observed by the writer, the dewberries and smooth-leafed blackberries have shown the greatest amount of spotting, while certain black raspberries and *R. odoratus* have been least affected. These differences have not been explained.

The following tentative suggestions for controlling the disease are based primarily upon the work of others, coupled with the writer's observational evidence.

1. Care should be taken to obtain disease-free plants for setting out new plantations.

2. Sources of inoculum should be reduced by destruction of dead leaves and old canes in the fall.

3. When conditions for the development of leaf spot are favorable, spray with Bordeaux mixture, 3–3–50, after the leaf buds are well opened, and at intervals of two or three weeks until the fruit is two-thirds grown.

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BRIEFER ARTICLES

FIJI DISEASE OF SUGAR CANE IN THE PHILIPPINE ISLANDS

OTTO A. REINKING

WITH PLATES XV AND XVI

The Fiji disease of sugar cane has been present in the Philippine Islands for some years. It has been identified as such in sugar cane fields on the Island of Mindoro and about Calamba on the Island of Luzon, and undoubtedly is present in other sugar cane sections. It has been present in the Philippines at least as far back as July, 1916, but no authenticated report of its presence was given until the writer had an opportunity to make an investigation of the diseased fields in December, 1920. The disease has been extremely destructive, especially to foreign varieties of cane such as Java 247 and Hawaii 109. Losses of from fifty to seventy-five per cent have occurred in heavily infected fields. In the infested regions it has spread rapidly from one plantation to another through the use of infected tops for planting. Certain Philippine sugar canes are not so severely affected and little damage is done where these varieties are grown. The use of these canes on plantations in the Philippines, along with crop rotation, appears to be an effective method of control.

SYMPTOMS OF THE DISEASE

Badly affected plants, due to the shortening of the internodes, are small, stunted, and have a bunchy growth of leaves produced at the top (Plate XV, figs. A and B). An excessive number of shoots is developed, and the leaves produced are small and slender. The leaves of such plants are a darker green than normal and usually are more upright and slender. The darker green is present even on plant sugar cane that has been affected apparently only for a few months. Otherwise, in the latter cases, the appearance of the sugar cane is normal except for a slight stunting, the more upright leaves, and the production of galls. Galls are almost always present on the leaves of diseased plants.

In young and old cases of disease, galls are produced on the leaves. On young cases of infection, in which the leaves are almost normal, being natural in size, but a darker green, the galls, in all stages, may be well developed. They are characterized by raised elongated blisters produced on the under surface of the leaf, either on the main vein or on the smaller veins (Plate XVI, figs. A, B, C). They extend lengthwise of the leaf. The galls in such cases are from two millimeters to six

FIJI DISEASE OF SUGAR CANE

Fig. A. Bunchy top and excessive number of shoots caused by this disease.
Fig. B. Stunted tops with small, slender leaves.

or more centimeters long. The young galls are a lighter green than the leaf. If a diseased leaf is held up to the sun, the galls are indicated by a translucence of the affected parts. The majority of the galls are present on the lower portions of the leaf blade down near the leaf sheath. They may, however, extend out to the tips of the leaves and form upon the young green leaves even before they have unrolled (Plate XVI fig. A).

In advanced cases the galls are usually produced in greater abundance on the leaf blade, but may also be found on the leaf sheath. No galls have been observed on the stem of the cane nor do they extend through the leaf. There is a slight yellowing on the upper surface of the leaf above the gall. At first the galls are light green, but later become much thickened, opaque, frequently turn reddish in spots, then brownish, and in such cases they may burst open exposing a brownish mass (Pl. XVI, fig.C). The galls are present in abundance on old dead and dried leaves and these may be a source of infection. Galls on dead leaves usually are not ruptured.

In diseased, plant sugar cane, the root system is abnormal, being small, bunchy, and slightly rotted. On ratoon, diseased canes the root system is smaller and more decayed. A rot may extend from the dead roots into the stems.

New shoots arising from the bases of such diseased plants often have a yellow streak running down the central group of unfolded leaves. In advanced cases these shoots may be rotted and the diseased condition may extend for a short distance into the stem. In the earliest stages the shoot rot is characterized by a yellowing of the exposed leaves and later by a reddening of the young rolled-up leaves within the sheaths. The leaves finally die and the entire inner part of the shoot is affected with a brown soft rot. A bad odor is present in these advanced cases. The small shoots developing from the base of a badly diseased, ratoon sugar cane are generally diseased. Frequently in such advanced cases the diseased leaves are distorted and much wrinkled. A rot is not always associated with this disease. When present it appears to be a secondary trouble caused by some other organism that attacks the weakened canes. Usually there is no discoloration of the interior of the canes of diseased plants except at the nodes where a shoot arises and just above the root system. At these points a yellowing or reddening may be present.

Instances have been observed in which the entire cane from the roots to the top is somewhat pithy and soft. No discoloration or decay was observed in these cases. The tops of such plants are very bunchy and numerous galls are produced on the leaves. This characteristic of the pithy center apparently is not general, as it was only noticed in a few

cases. Frequently in plant sugar cane, one stool of a plant is visibly diseased and the rest appear to be free from disease. It is reported, however, that tops taken from any stool of such a plant will develop the disease.

Plasmodia-like bodies appear to be present in old and young galls. These bodies are light colored in the young, and brownish and more granular in the older galls. These bodies are also present in the cells of the young shoots that arise from the base of the diseased plants. Questionable fungous bodies are present in the rotted roots and base of the stem. The presence of the fungal bodies would indicate that a fungus is responsible for the disease. It will be first necessary to conduct isolation and inoculation experiments before this can be definitely settled. At present, from all indications, it appears that the causal factor gains entrance to the plant through the root system, and that it may remain in the soil for at least one year.

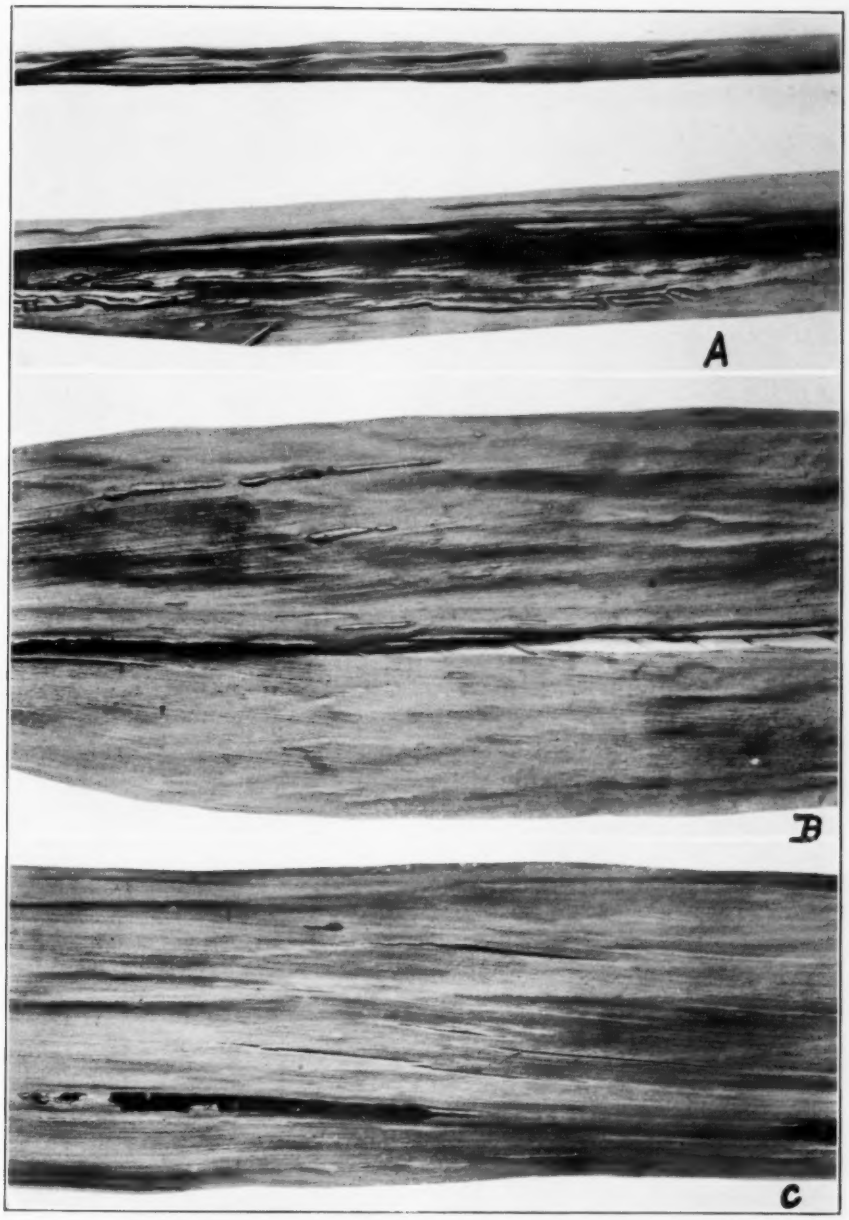
TABLE 1

Observed susceptibility of the varieties of sugar cane to the Fiji disease

FOREIGN VARIETIES OF SUGAR CANE		PHILIPPINE VARIETIES OF SUGAR CANE	
Demerara 152	—No disease seen.	Cebu Purple	—No disease seen.
Demerara 247	—Diseased.	Lamao White	— " " "
Demerara 604	— "	Luzon White	—Diseased medium.
Demerara 625	— " severely.	Negros Purple	— " slightly; sporadic.
Demerara 1135	— "		
Hawaii 16	— "		
Hawaii 20	— "		
Hawaii 27	— "		
Hawaii 69	— "		
Hawaii 109	— " severely.		
Hawaii 146	— "		
Hawaii 227	— "		
Hawaii 309	— "		
Java 100	—No disease seen.		
Java 213	— " " "		
Java 247	—Diseased severely.		
Java 826	—No disease seen.		
Lahaina	—Diseased.		
Striped Mexican	— "		
Yellow Caledonia	— " medium.		

FIELD OBSERVATIONS

The disease does not seem to show any difference in severity on plants growing on various types of soil. The infection in fields of Java 247 and Hawaiian varieties is severe both on heavy clay soils and on lighter loam soils. The disease is always more serious on the ratoon sugar



LEAF GALLS CAUSED BY FIJI DISEASE

Fig. A. Early stage of gall formation in leaves still rolled at the growing tip of the cane.

Fig. B. Galls before breaking open.

Fig. C. Galls broken open.

cane than on the plant sugar cane. Cases, however, are known where the disease is bad on plant sugar cane that is about ready to be cut. In these cases the plants are stunted and numerous galls are produced on the leaves. The chief danger in such fields is that the tops are cut for seed, and consequently the disease is widely spread throughout the plantation. Ratoon sugar cane from seriously infected, plant sugar cane may show losses of from fifty to seventy-five per cent in localized areas.

Up to date, all Philippine varieties are not severely affected. Many instances were observed where Hawaii 109 and Java 247 were planted together with the Negros Purple. Even when the severely infected Hawaiian or Javan varieties were growing intermingled with Philippine sugar cane, the infection on the latter was not severe. Negros Purple is attacked, but the disease does not appear to be so severe as on the foreign varieties. Table 1 gives a list of the different varieties of sugar cane examined, and indicates those varieties that were found to be affected.

No Fiji disease was observed on talahib, the wild sugar cane (*Saccharum spontaneum*).

Further observations may prove that the Java and Demerara varieties enumerated as being free will contract the disease. The Philippine sugar cane, however, in all instances thus far has shown marked resistance, but further investigation may prove that it is more severely attacked.

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FALLING FOLLIAGE

MEL T. COOK[1]

Many inquiries concerning the falling of the foliage of both shade and fruit trees coming to the writer every year has led to field studies to determine the causes. These studies have been continued over a period of several years and are in the nature of observation rather than experiments. There were many more inquiries during the spring and summer of 1919 than usual and the number of varieties of trees affected much greater than usual. Therefore, the opportunities for study much greater than on previous or succeeding years. It is very evident that there are many factors which cause the falling of tree foliage. They will be taken up separately.

[1] Technical paper No. 27 of the New Jersey Agricultural Experiment Stations, Department of Plant Pathology.

LOW TEMPERATURE

This may be the cause of the falling of foliage, even though the temperature is not low enough to cause frost. The character and extent of the injury appears to vary with the age or stage of development of the foliage. It is well known that trees standing side by side do not necessarily develop their foliage with the same degree of rapidity which no doubt explains the variation of foliage injury.

Among the most susceptible trees are the apple and the beech. Many apple leaves turn yellow before falling but some fall which are almost green. This falling is most noticeable until the leaves have reached their full size, which may be some time after the period of low temperature. The growers having forgotten the period of low temperature very naturally look for some other explanation. The explanations most generally given are fungus or spray injury. The first can usually be eliminated because at this time the foliage fungi of the apple are not well advanced and few or no spots are visible. The second factor frequently requires careful consideration, especially if the trees have been sprayed with mixtures containing copper compounds. Many cases of this kind came to the writer's attention in 1919 and were traced to low temperature as the causal factor.

The young foliage of the beech is especially susceptible to low temperatures. The leaves show a peculiar burning or drying along the margins and frequently between the veins. In severe cases the leaves fall in great numbers and occasionally the trees are almost defoliated. In other cases leaves with brown areas may persist throughout the season. Trees standing very close together frequently show great variations in injury due to different stages of development at the time of low temperature. The injury is apparently due to the low temperature, soon after the buds open and before the leaves have reached full size and at a time when the protoplasmic activity must be very high and the cuticle very poorly developed. Some cells may be killed and others injured in different degrees; the dead cells becoming brown, the others growing and often producing more or less irregular leaves.

SUN SCALD AND DROUTH

The soft and sugar maples are especially susceptible to sun scald and drouth injuries although other trees are often effected. It is most common on trees planted along streets or in other places where the water supply is greatly reduced because of pavements or where the heat is reflected from pavements. Trees on lawns where the soil is usually very hard or on slopes which allow the water to run off rapidly, instead of soaking into the ground are also subject to injury. The leaves first

show a streaking between the veins, very often the entire areas between the veins are affected, the entire leaf may become yellow, or irregular blotches may be formed. Norway maples are less susceptible than the soft and sugar maples, but sometimes have the appearance of being scorched. The foliage of the red maples is sometimes spotted with yellowish blotches.

This may be classed as a physiological disease due to a lack of balance between the amount of water taken in by the roots and the amount given off by the leaves. It can be corrected by heavy pruning. Trees growing under the conditions referred to should have 25 per cent or more of the branches removed every year. This treatment has been practiced by the writer with most satisfactory results.

Injuries of this kind are sometimes due to heat reflected from pavements or walls and may be classed as *sun scalds*. Injuries due to fumes, smoke or dust may be confused with those due to drouth or intense heat. These injuries are not necessarily accompanied by a falling of the leaves.

WEAK TREES

Trees which are weak for want of suitable soil, plant food, water, or insect injuries are very likely to lose foliage in mid summer.

SPRAY INJURIES

Spray mixtures which are improperly made or improperly applied will frequently cause severe injuries and the falling of leaves. Unfortunately we do not know much about the action of these mixtures on shade and ornamental trees. A few years ago the writer's attention was called to a very puzzling case of the falling of shade tree and peach tree leaves. An investigation proved it to be due to Paris green dust which had drifted in from the adjoining potato fields at the time of application. The leaves were falling in great numbers and the new wood showed unmistakable evidence of injury. The first row of trees in adjoining peach orchards showed severe injury and the succeeding rows showed relatively less. The wild cherry growing along the fence rows also showed very pronounced injuries on both leaves and new growths.

Arsenate of lead and lime sulfur are common causes of foliage injuries but are not necessarily accompanied by a falling of the foliage. Spray mixtures containing sulphate of copper when applied to fruit trees are very likely to be followed by a falling of the foliage.

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SEED TRANSMISSION OF SOYBEAN BACTERIAL BLIGHT

JAMES B. KENDRICK AND MAX W. GARDNER[1]

WITH PLATE XVII

In 1919, Miss Coerper[2] described and illustrated the lesions of bacterial blight on soybean pods and stated that the seeds may become affected. Furthermore she found the disease on the first leaves of the plants in the field and suggested that the organism may live over winter on or within the seed. In a later report[3] on this disease from the University of Wisconsin, it is stated that the disease is seed-borne and that seed selection was being studied as one method of control.

In 1920, Wolf[4] in his description of the same or a very similar disease noted the lesions on cotyledons just emerging from the soil but did not find lesions on the pods. He expresses a belief, however, that the seed is primarily responsible for the overwintering and carriage of the disease and suggests that seed contamination occurs after the pods have matured. Wolf also observed that the disease appeared in new fields planted with seed from diseased fields.

Thus all the observational evidence has pointed towards seed transmission and it has proved comparatively easy to confirm this suspicion by greenhouse tests. In 1920 bacterial blight occurred in abundance in a field of soybeans near Lafayette and pod lesions were rather common. In October a considerable quantity of the ripening, infected pods (Pl. XVII,A) were collected. The seeds were removed and those borne directly under pod lesions were kept separate from the rest. Many of the seeds from under pod lesions showed actual lesions (Pl. XVII, B) as a result of the penetration of the infection through the ovary wall and others appeared to be smeared with the bacteria as noted by Miss Coerper.

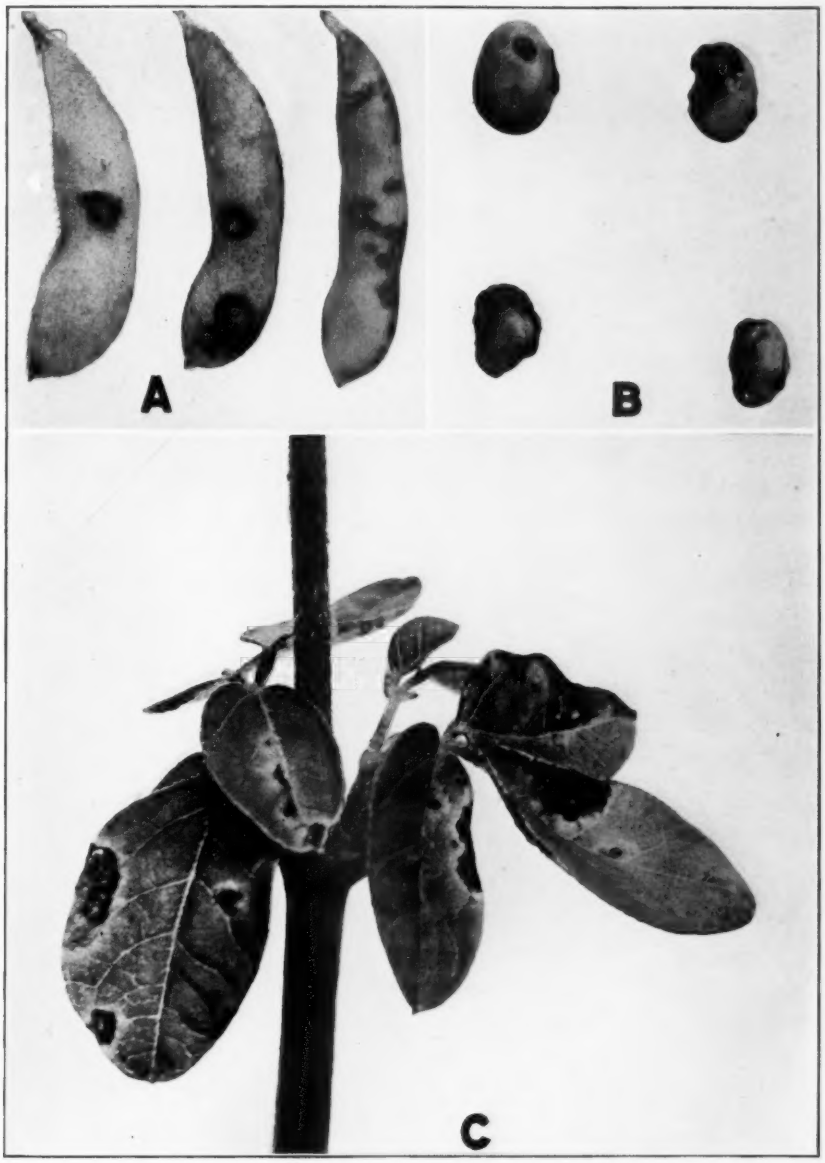
October 25, about 220 of these seeds from under pod lesions were planted in 40 small pots of sterilized soil and about 55 seeds which were borne in diseased pods but not directly under lesions were planted in

[1] Contribution from the Botanical Department of Purdue University Agricultural Experiment Station, Lafayette, Indiana.

[2] Coerper, Florence M. Bacterial blight of soybean. Jour. Agric. Research **18**: 179–194. 1919.

[3] Annual report of the director (Experiments in farming). Plant pathology investigations. Wis. Agric. Exp. Sta. Bull. 319: 30–31. 1920.

[4] Wolf, Frederick A. Bacterial blight of soybean. Phytopath. **10**: 119–132. 1920.



BACTERIAL BLIGHT OF SOYBEANS

Fig. A. Soybean pods showing bacterial blight lesions.

Fig. B. Seeds showing lesions (× 2).

Fig. C. Blight infection on leaves of secondary shoots from cotyledon node of seedling grown from seed from diseased pod. (Enlarged).

10 small pots of sterilized soil. The plants grew slowly and until January 25, 1921, no disease was noted. At that time 116 plants of the first series and 32 of the second series had come up and 13 of the 116 and three of the 32 showed lesions of bacterial blight on the leaves, especially the leaves on the secondary shoots from the cotyledon nodes (Pl. XVII, C). None of the 124 control plants grown in sterilized soil from seed selected from pods showing no lesions developed bacterial blight.

December 9, sixty seeds from underneath lesions were planted in 20 small pots of sterilized soil. Out of the 23 plants which had come up January 25, three showed blight lesions. Thirty seeds from diseased pods but not borne beneath lesions were planted the same date and, out of the 15 plants which were up January 25, one showed bacterial blight. None of the 106 control plants from seed from healthy pods developed the disease.

January 29, more of the seed from diseased pods but not from underneath lesions was planted in unsterilized soil and, out of 30 plants resulting, two showed the disease March 29.

A summary of the results of the tests in sterilized soil shows that 16 out of 139 plants from seed borne under pod lesions or about 11 per cent developed bacterial blight and that four out of 47 plants from seed not borne directly under pod lesions or about 8 per cent developed the disease. Thus it is evident that a considerable percentage of the viable seed from diseased pods gives rise to diseased seedlings. Also it would appear that infection may be carried externally or internally with the seed.

In order to determine the identity of the causal organism, isolations were made from a cotyledon node lesion and a leaf lesion. Typical whitish colonies appeared and successful inoculations and reisolations were obtained.

Owing to the confusion in the literature relative to this disease, it seemed necessary to determine whether the organism involved was *Bacterium glycineum* Coerper or *Bacterium sojae* Wolf by use of the tests conducted by Shunk and Wolf.[1] Three strains were used, one the original isolation from a nodal lesion tested for purity by poured plates and for pathogenicity by inoculations and designated as the Indiana strain, and the other two, strains No. 211 and No. 269 from the University of Wisconsin laboratory. The latter were two of the strains tested by Shunk and Wolf who concluded that No. 269 was typical of *Bact. glycineum* and No. 211 of *Bact. sojae*. These strains or species are to be distinguished by their pigment production and influence on the hydrogen-ion concentration of certain media.

[1] Shunk, I. V. and Wolf, F. A. Further studies on bacterial blight of soybean. Phytopathology **11**: 18–24. 1921.

Four series of tubed media containing 2 per cent peptone and as a carbon source either dextrose, saccharose, maltose, lactose or glycerin in concentrations of 1 per cent were prepared according to the method employed by Shunk and Wolf, that is, the carbon compounds were sterilized separately and added later. Three series were broth media. One contained the indicator brom cresol purple and another brom thymol blue in concentrations of about .0016 per cent. One contained no indicator. The fourth series consisted of agar slants containing the indicator brom cresol purple. All were adjusted to about pH = 7.3. Seven days after inoculation the pH values were determined by direct reading of the colors in the media containing the indicators and by the addition of the indicators mentioned as well as phenol red and methyl red to the series containing no indicator. The results are tabulated below.

STRAIN	DEXTROSE		SACCHAROSE		MALTOSE		LACTOSE		GLYCERIN	
	pH	PIGMENT	pH	PIGMENT	pH	PIGMENT	pH	PIGMENT	pH	PIGMENT
Indiana (*Bact.*)	5.6*	None	6.7	None	7.3	None	7.3	None	7.3	None
211 (*sojae*) (*Bact.*)	6.5	None	6.6	None	7.3	None	7.3	None	7.3	None
269 (*glycineum*).	5.4	None	6.0[1]	Very light brown	7.4	Brown	7.3	Brown	7.3	Brown

* After three weeks incubation these values became similar to those of No. 211.

The results with the Indiana strain checked very closely with other series of somewhat similar tests in which the other two strains were not used.

From these results it is evident that the Indiana strain is somewhat intermediate in its hydrogen-ion relations but more closely resembles No. 211 and in its failure to produce a brown pigment distinctly resembles No. 211. The pigmentation character in peptone media containing maltose or lactose seems to be the most reliable and convenient means of differentiating these strains.

In summary it may be said that bacterial blight of soybean is transmitted with the seed from diseased pods. The organism involved in these tests closely resembles the non-pigment-producing strain No. 211 of *Bact. glycineum* which is considered by Shunk and Wolf as identical with *Bact. sojae*.

PHYTOPATHOLOGICAL NOTES

Internal aecia of Puccinia albiperidia Arthur.—In view of the general occurrence of internal rust sori as indicated by the observations of Clinton,[1] Colley,[2] Hungerford,[3] and others, the following report is of interest.

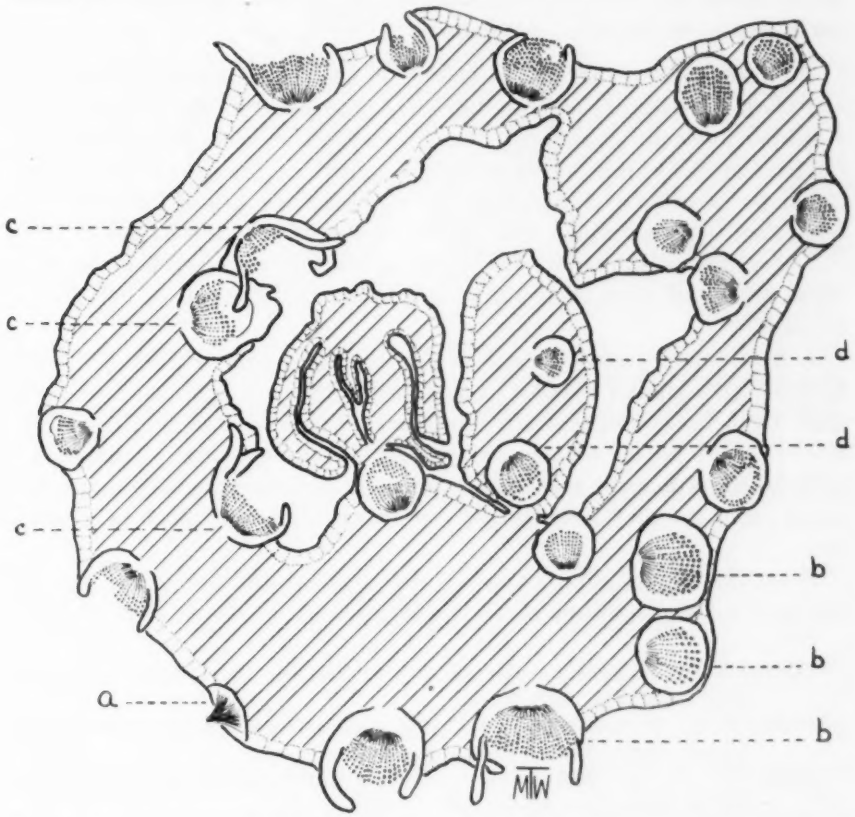


FIG. 1. CROSS SECTION THROUGH A FRUIT OF RIBES GLANDULOSUM INFECTED WITH PUCCINIA ALBIPERIDIA Arth. SHOWING PYCNIUM (a), AECIA (b), INTERNAL AECIA (c) AND AECIA IN SEED (d).

Early in June, 1920, a rusted mummified fruit of *Ribes glandulosum* was collected at Temple, New Hampshire, by J. L. Richards in connection with work on *Cronartium ribicola*.The rust was determined as *Puccinia albiperidia* Arthur, the outer surface of the fruit being thickly

covered with aecia (Fig. 1, b) and with a very few pycnia (Fig. 1, a). A study of sections through the berry revealed the presence of abundant internal aecia (Fig. 1, c) projecting into the hollow central cavity. These internal aecia were perfectly normal in appearance and proportionately as numerous as those on the external surface. Aecia were also present in a few of the seeds. (Fig. 1, d.)

While internal aecia have been definitely observed in *Nigredo caladii* (Schw.) Arthur,[6] *Puccinia graminis* Pers.,[6] *P. graminis*?[5] *P. angustata* Peck,[6] *P. cari-bistortae*,[4] and *Gymnosporangium macropus* Lk.[1], so far as the writer can learn internal aecia have not been previously reported for *Puccinia albiperidia*.—MINNIE W. TAYLOR.

Anaerobic bacteria in plant tissues. Most bacteria described as causing plant diseases are aerobic, but some may grow in the absence of air if proper foods are available.[7] Instances are here recorded of anaerobic bacteria growing from pieces of diseased plant tissues inserted in culture media so as to be excluded from the air. No colonies of bacteria grew from similar pieces which were left on the surface of the media.

1. Sections of tumors on *Picea excelsa* produce bacterial colonies only when immersed more than 5 mm. in peptone-glucose agar or gelatinized arbutin.[8]

2. Sections of diseased roots of *Juglans regia* from Nuces, Aveyron, France[9] gave similar results. Grayish, gummous zoogloeae of bacteria grew from imbedded sections downward to the bottom of the culture tube. Those placed on the surface produced no colonies. These anaerobic bacteria may be responsible for the gummosis observed in the diseased roots, as they precede the fungus invaders and produce a black rot.

From the above facts it appears that parallel cultures under aerobic and anaerobic conditions should be made.—JEAN DUFRENOY.

[1] Clinton, G. P. Notes on fungous diseases, etc. for 1908. Rept. Conn. Agric. Exp. Sta. **1907–1908**. 853. 1909.

[2] Colley, R. H. Discovery of internal telia produced by a species of Cronartium. Journ. Agric. Res. **8**: 329–332. 1917.

[3] Hungerford, C. W. Rust in seed wheat and its relation to seedling infection. Journ. Agric. Res. **19**: 257–276. 1920.

[4] Klebahn, H. Puccinia cari-bistortae. Zeitschr. Pflanzenkrank. **9**: 158. 1899.

[5] ———— Kryptogamenflora der Mark Brandenburg **Va.**: 101. 1912.

[6] Wolf, T. A. Internal aecia. Mycologia **5**: 303–304. 1913.

[7] Smith, E. F. A conspectus of bacterial diseases of plants. Annals Mo. Bot. Garden **2**: 377–401. 1915.

[8] Dufrenoy, Jean. Sur des tumeurs bactériemes expérimentales de l'Epicea. Comptes Rendus Acad. Sci. (Paris). 171: 874–876. 1920.

[9] ———— Bactéries anaérobies et gommose du Noyer. Comptes Rendus Soc. Biologie **84**: 132–133. 1921.

Notes on Phoma insidiosa Tass. found on Sudan grass. In September, 1920 leaves of Sudan grass infected with *Phoma insidiosa* were collected at Arlington Farm, Virginia. The Sudan grass was growing in an experimental plot together with different varieties of grain sorghum. The fungus had produced brownish-drab colored spots with indefinite outline, on various parts of the leaves. The pycnidia were scattered within the discolored areas. They were brown or black in color and had somewhat protrudent ostioles.

Cultures were started seven months after the leaves had been gathered. The conidia germinated, the mycelium grew, produced chlamydospores and pycnidia on cornmeal agar in the manner characteristic of *P. insidiosa*, except that when growing in the light the mycelium did not produce the pink stain in the medium as the cultures of *P. insidiosa* from sweet sorghum had done.[1] The fungus was found to be parasitic on the leaves of a variety of sweet sorghum called Early Amber. The seedlings, growing in covered glass dishes, were inoculated with a water suspension of conidia taken from the cornmeal agar cultures. In two weeks pycnidia were found on the leaves of two young plants out of the fifteen inoculated. The five check plants remained sterile. The conidia produced on these infected sweet sorghum leaves were plated in cornmeal agar. A growth characteristic of *P. insidiosa* followed but now the mycelium produced a pink discoloration of the cornmeal agar when growing in the light such as the sweet sorghum Phoma produced.

TABLE 1

Measurements of pycnidia and conidia on leaves of Sudan grass and in cultures

SOURCE	PYCNIDIA			CONIDIA		
	NO. MEASURED	RANGE IN FT.	MEAN SIZE	NO. MEASURED	RANGE IN μ	MEAN SIZE
Leaf natural infection	10	54 to 86	65	10	3.5 to 3.9 × 4.4 to 7.9	3.5 × 6.2
Cornmeal agar cultures	10	84 to 168	128	10	2.6 to 4.4 × 5.2 to 7.9	3.4 × 6.7
Leaves of Early Amber seedlings inoculated in glass dishes	10	63 to 198	115	10	2.6 to 3.5 × 5.3 to 7	3.2 × 6.2
Cornmeal agar cultures	10	45 to 108	75	10	2.6 to 3.5 × 5.3 to 7	3.4 × 6.5

CAROLINE RUMBOLD AND ELIZABETH K. TISDALE

[1] Koch, Elizabeth and Caroline Rumbold, Phoma on sweet sorghum. Phytopath. **11**: 253 – 268. 1921.

Wilting caused by walnut trees. The writer's attention has been called from time to time to a number of cases of wilting of potato and tomato plants which was undoubtedly due to walnut (*Juglans nigra*) trees growing in the immediate vicinity. The plants show a pronounced wilting but do not lose their color or die as in the case of plants that have been attacked by wilt producing fungi or bacteria, or struck by lightning. The range of the wilting coincides very closely with the spread of the root system. The plants may wilt uniformly within a large circle or there may be areas of wilted and areas of erect plants which coincides with the distribution of the root system. In some cases the wilting was in a circular area around the trees in the field. In other cases in a semi-circular area next to trees along the margins of the fields. In all cases observed the plants beyond the spread of the roots of the trees were normal. A number of cases have been investigated by the writer and there is no doubt as to the cause of the wilting. So far as the writer has observed other crops are not affected by the walnut trees and other trees do not cause a wilting of crops or wild vegetation.—MEL. T. COOK.

Russian Mycological and Phytopathological Society.—Members of the American Phytopathological Society will be pleased to learn of the existence of a Russian sister society, now about a year old and apparently in good health. The writer of this note is in receipt of the constitution of the society and of a partial list of its members. He is indebted for these documents to an American, Mr. H. W. Truesdell, formerly engaged in phytopathological work in this country and now on a professional visit in Russia. While in Petrograd during the early part of March, 1921, he met there the well known Russian mycologist and plant pathologist, Prof. A. A. Jaczewski. He states that the latter gave him a great deal of information and copies and separates of a large number of his publications. Like the scientists in other lines of work, Professor Jaczewski has a number of unpublished manuscripts ready for the printer. Being shut off for a long time from the outside world, under the grave conditions of the war and civil war, Russia suffers from extreme shortage of typographic supplies and material. Professor Jaczewski also showed to his visitor his laboratory, which appeared to be "well equipped and in good order, as good as the best anywhere." However, on account of the fuel shortage it was unheated and "about 0° C." when the American visited it. Next the laboratory were two heated rooms, occupied by Prof. Jaczewski and his family. All the members of the family apparently were well and "living as well as anyone else at the present time" in Russia. As a crowning act of Russian hospitality, the Russian scientist invited his American guest to take tea with them.

Prof. Jaczewski is now the president of the Russian Mycological and Phytopathological Society. It was founded in 1920, and is affiliated with the Russian Botanical Society under the name of "Permanent Commission on Mycology and Phytopathology at the Russian Botanical Society." Other officers in Petrograd are: V. Tranzschel, vice-president; N. A. Naumov, secretary, and N. Vavilov, chief editor. The address is the same as that of the former Bureau of Mycology and Phytopathology before the war: 29 English prospect. There is also a branch of this Society in Moscow, of which Prof. V. Talyev is the president (address: Sadovaya Triumphalnaya, House of the Gubernskoe Zemstvo).

The constitution and the by-laws of the Russian Society reveal a somewhat broader field of activities than is usually associated with similar scientific societies in other countries. The society, in fact, appears to be organized for the purpose of *united* scientific endeavor and harmonized *work*. The object of the Society is three-fold: conduct of investigations in mycology and phytopathology, promotion of this work in Russia, and dissemination of mycological and phytopathological knowledge through the country. For the attainment of this object the following means are designated: meetings, conferences, and consultations; courses and public lectures; excursions and expeditions; organization of mycological stations, laboratories, museums, and like institutions; publications, and material assistance to the specialists carrying on the research. The Society is composed of actual, associate and honorary members. Foreign mycologists and phytopathologists may become actual as well as honorary members. The Society holds regular, annual, and extraordinary meetings. Joint meetings with economic entomologists are held from time to time as the necessity requires.

The partial list of members sent to the writer contains several familiar names which appeared previously in the pre-war Russian literature. Such are, for instance, in addition to the above mentioned officers of the Society: Bondartsev, Dorogin, Ohl, Lebedeva. Most of the members are new workers, a great proportion of whom are women. Of the thirty-seven members named in this list, twenty-two are men and fifteen women. This entry into the field of plant pathology of a relatively large number of Russian educated women is a new and interesting social phenomenon.—M. SHAPOVALOV.

Ravn Scandinavian-American fellowship in plant pathology.—In recognition of the important services to humanity, particularly in the field of plant pathology, of the late Dr. F. Kölpin Ravn of Denmark, a movement was started in connection with the Chicago meetings of the American Phytopathological Society looking toward the establishment of a fellowship in the United States for graduate students of Norway, Sweden, or Denmark, who are planning to make plant pathology their life work. The matter was referred to a special committee of which Dr. L. R. Jones was made general chairman. Others on the committee are Drs. Donald Reddick, A. G. Johnson, H. H. Whetzel and Mr. R. Kent Beattie.

The committee in considering ways and means for handling the whole matter will welcome suggestions from any source bearing on any phase of the proposition.

Personals.—Dr. Arthur H. Graves, of New Haven, Conn., has been appointed curator of public instruction at the Brooklyn Botanic Garden to take effect September first. Dr. Graves was formerly assistant professor of botany in the Sheffield Scientific School and the School of Forestry of Yale University, and more recently professor of botany at the Connecticut Women's College.

Prof. Dr. C. Ferdinandsen, professor of plant pathology at the Royal Agricultural College, Copenhagen, is making a brief visit to this country. He visited Washington, D. C., Madison, Wis., Ithaca, N. Y., and New York City. While in Washington he addressed the Phytopathological Seminary on Phytopathology in Denmark. Dr. Ferdinandsen is the successor to Dr. F. Kölpin Ravn who was so well known to American pathologists.

The July number of Phytopathology was issued Nov. 15, 1921.